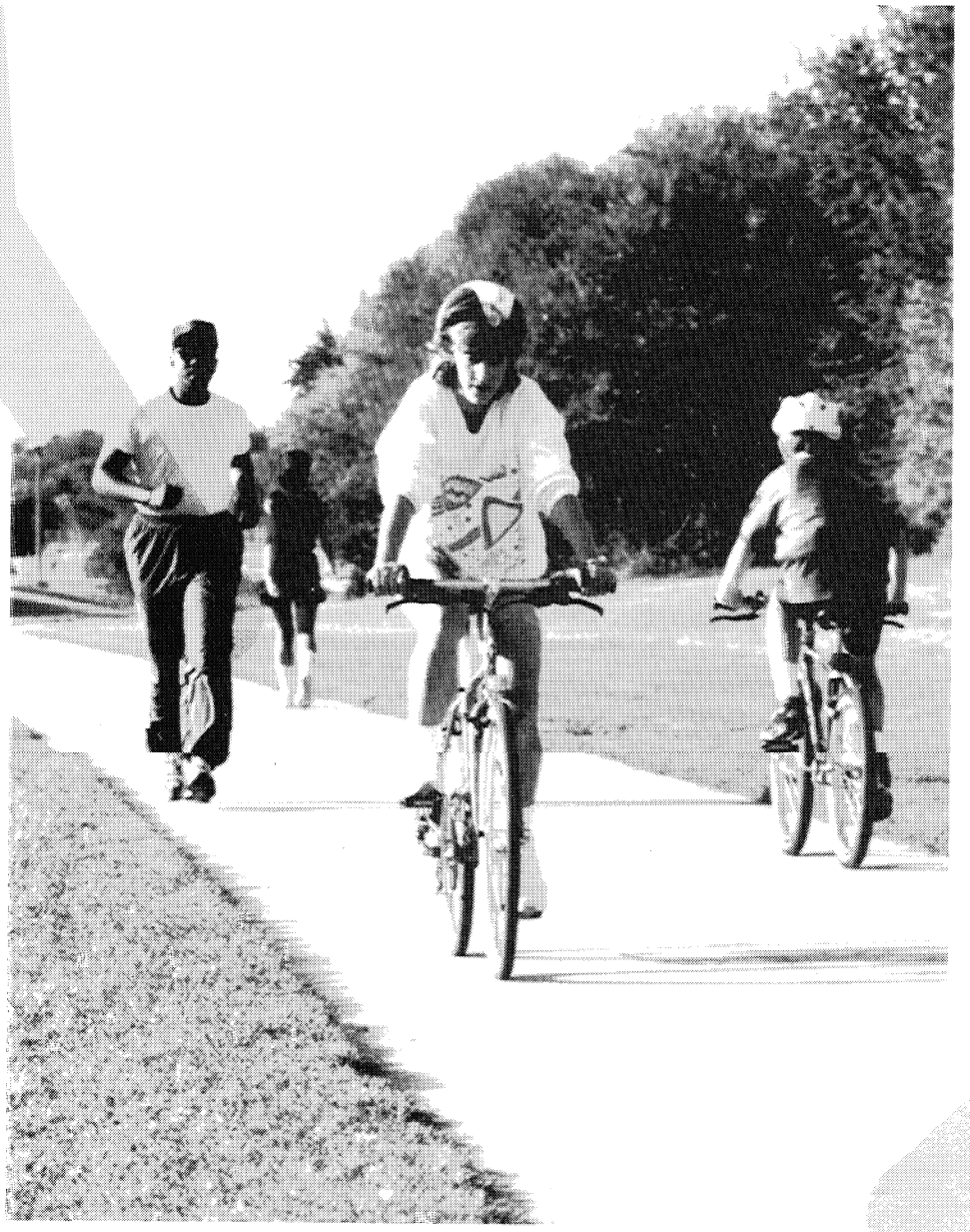
Publication No. FHWA-PD-92-038



Case Study No. 2

The Training Needs of Transportation Professionals Regarding The Pedestrian And Bicyclist

U.S. Department
of Transportation
Federal Highway Administration

National Bicycling And Walking Study

Foreword

This case study was prepared under contract for the Federal Highway Administration by Everett C. Carter and David M. Levinson of the University of Maryland Transportation Studies Center.

Notice

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Submitted to:

Federal Highway Administration
400 Seventh Street, S.W.
Washington, DC 20590

1992

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Executive Summary

This paper is entitled "The Training Needs of Transportation Professionals Regarding the Pedestrian and Bicyclist." The transportation professional as used here is generally someone with engineering, planning, or enforcement training, who serves in that capacity as an educator or as an administrator of a surface transportation system. In planning, designing, or administering the transportation system, the user must be kept in mind. This user wants to take the safest and most efficient means of travel from origin to destination, and so may choose to walk, bike, take transit, or drive. However, in most American college transportation planning and engineering programs, attention is paid only to the automobile mode, with an elective course offered on transit design. No provision is made for studying exclusively the needs of the pedestrian or bicyclist, and little discussion is provided in more general courses on how to integrate modes together. Compensating for this absence of coverage is the focus of this paper.

Transportation professionals generally have a handful of common references on their shelves or in their office. These include the AASHTO Green Book, the ITE ***Traffic Engineering Handbook,*** the ***Highway Capacity Manual,*** and the ***Manual of Uniform Traffic Control Devices.*** These books are geared strongly to the automobile, and although some improvements can be made, they will still not be able to fulfill the need for a comprehensive reference on bicycle and pedestrian planning and engineering. These improvements include the following:

- incorporation of the AASHTO ***Guide for the Development of Bicycle Facilities*** into the next edition of ***A Policy on Geometric Design of Highways and Streets*** to formalize and better distribute the information;
- providing specific chapters each on pedestrian and bicycle transportation as is done with other modes, into the next ITE ***Transportation Planning Handbook;***
- improving the currently weak Pedestrian and Bicycle Chapters in the next ***Highway Capacity Manual;***
- development of bicycle facility warrants and signage standards for ***woonerf*** type areas in the ***Manual of Uniform Traffic Control Devices;*** and
- revising the ***Uniform Vehicle Code*** and ***Model Traffic Ordinance*** to make stronger provision for auto-restricted and auto-prohibited areas.

A number of specialized books geared to transportation professionals on bicycle and pedestrian issues were reviewed. The ASCE ***Bicycle Transportation: A Handbook for Civil Engineers*** could serve as the text for a graduate course or continuing education class on

designing facilities for bicycles. A course on pedestrians would need to refer to several books, the best of which, while good, is dated and could stand to be revised or supplanted by a new text on pedestrian planning and design. Such a text would need to cover not only the urban situation, but also suburban and small town conditions. The text ***Pedestrian Planning and Design*** by Fruin is the most objective and comprehensive of the books reviewed. Neither bicycle nor pedestrian specific texts are general transportation system design guides. The ITE ***Residential Street Design and Traffic Control*** provides a current and comprehensive review of techniques for creating or remaking a transportation system which respects nonmotorized transportation in residential areas. An authoritative text on nonmotorized transportation that included the best of all of the reviewed texts, and incorporated the latest research, would do well in providing a foundation for a course on these topics.

After reviewing the ASCE Human Powered Transportation Subcommittee's survey of civil engineering programs, it is obvious that there are no complete courses on nonmotorized transportation offered in the United States, and little desire by most educators to provide one. An informal review of continuing education programs revealed the same. Professional committees are not filling this vacuum. Fostering a safe and efficient transportation system which includes pedestrian and bicycle transportation for shorter length trips requires that the body of transportation professionals understand the needs of the users of these modes. Formal training in graduate school is one means for creating this understanding; continuing education programs are a second way.

The major professional and research organizations in the transportation field treat the pedestrian and bicycle as ancillary. As professionals become more cognizant of the pedestrian and bicycle, this may change. In order to encourage more rapid change, some incentive must be provided. Additional research funds would promote additional papers submitted to TRB and spur more committee activity. An incentive to produce a Pedestrian and Bicycle Handbook from ITE or ASCE might awaken interest in the topics within these organizations.

We recommend that a trial continuing education course on nonmotorized transportation be created, marketed, and tested. This would require enhancing current texts and developing a curriculum. If this proved successful, it could easily be expanded and offered at multiple sites throughout the United States. Success would encourage universities to offer college credit for a course and to teach it themselves. At first, a subsidy may need to be offered to fund the program, although in time a successful course would be self-financing. This report presents a syllabus for such a course.

We also recommend that useful Federal publications on pedestrian and bicycle facility design be reprinted and distributed though the Technology Transfer (T^2) program. Better distribution and clearer presentation of a catalog of current Federal publications might improve the utility of the T^2 program for this and other areas. Organization of this catalog would point out gaps in current research that could be addressed with further research and synthesis of knowledge.

Highway funds were made available for a wide range of bicycle and pedestrian projects by the 199 1 Intermodal Surface Transportation Efficiency Act (ISTEA). This act also requires bicycle and pedestrian coordinators in each State Department of Transportation. In addition to traditional design training, these individuals will need training in bicycle and pedestrian program management.

In short, transportation professionals currently receive essentially no training in planning or design of nonmotorized transportation. This lack of training is self-perpetuating, as those who were not trained themselves do not see the need to train future professionals. Only a concerted effort through incorporation of coursework on pedestrians and bicycles in the transportation engineering and planning curriculum, and by corrective action for professionals through continuing education programs, can reverse this situation.

1 . Introduction

1.1 Who Is a Transportation Professional

When undertaking a study to determine the training needs of transportation professionals, one must first define who is a "transportation professional." The term "transportation professional," as used here, will be defined as given by the Transportation Research Board in ***Transportation Professionals: Future Needs and Opportunities*** [TRB, 1985]. That study defined a professional as someone who met the following conditions:

1. ***A registered professional,***

2. ***A person who has received an undergraduate or advanced degree in a professional field, or***

3. ***A person, not necessarily a registered or degreed professional, who fills a position classified with a professional title such as "engineer" [or planner].*** [TRB, 1985]

In this context, the profession as understood here will be composed primarily of planners, engineers, educators, and administrators who deal with transportation.

1.2 Transportation System Balance

Transportation is concerned with the movement of people and goods, ideally with safety and efficiency. The transportation decision involves multiple choices, where, when, and how to go, which includes the selection of the appropriate mode. All too often, the field as practiced is reduced to a myopic view of individual modes, for instance, the highway engineer or the transit planner, and does not provide serious consideration of planning and designing for multiple, competing, or complementary modes of travel. The user of the transportation system prefers options in means of travel; this includes being able to travel quickly, and in a motorized vehicle for long distance trips, while having the choice of using human powered or nonmotorized modes, including walking and bicycling, for shorter trips. Both the long motorized and short nonmotorized trips need to be safe and efficient.

The main focus of transportation engineering and planning in the United States has been the automobile; all other modes are viewed as peripheral. One of the key questions raised, and implied in the title of the work, is whether this overwhelming focus, often to the exclusion or diminishment of other modes, remains valid given changing societal goals. That the automobile, given current technology, uses more energy and generates more pollutants than a nonmotorized mode for the same trip is unarguable. The key question is the cost of the trade-off of community, environmental, and energy costs for the convenience and opportunity provided by the automobile's faster speed.

Much of the United States' transportation educational establishment sees no reason for change [HPTE, 1991]. However, there is clearly a disparity between transportation modes as they are used and the educational resources devoted to them. Particularly, any objective analysis would conclude that one collegiate single credit course in the entire United States on each of the Pedestrian and the Bicycle as transportation is unrepresentative. Moreover, if there is a desire to make transportation professionals more sensitive to nonmotorized transportation in the hope of increasing the quality and usability of these modes, through various means, then the weighting of curriculum towards these modes should be greater than their usage share, not less.

The places to improve the knowledge of transportation professionals regarding the pedestrian and bicyclist are two-fold, the formal education system, including universities and training programs, and the professional literature, both through reference works and journals. In each, there needs to be both integration of pedestrians and bicyclists into the main body of work, and separate specialized treatment of pedestrians and bicyclists.

This report will contain four chapters beyond this Introduction. The next section will review the standard texts and references used by transportation professionals as well as potential specialized references. It will be shown that the more general works give short shrift to human powered transport in favor of motorized modes, while specific references on nonmotorized travel provide better coverage of the pedestrian and bicyclist, but may not yet be as good as they could be due to the lack of demand for such material.

The third chapter reviews existing training programs and the work of several committees in this field. The programs included are the FHWA/NHTSA Bicycle and Pedestrian Safety and Accommodations; the ASCE Subcommittee on Human Powered Transportation; and the activities of relevant professional committees. The Transportation Research Board committees interviewed include those on Pedestrians (A3B04), and on Bicycling and Bicycle Facilities (A3B07). Relevant Institute of Transportation Engineers (ITE) committees were also queried, including those of Pedestrian Signal Education Plaques (4S-2), Bicycle Safety Measures (4S-3), Design of Pedestrian Facilities (5A-5), Pedestrian Crossing Material (5P-3), Guidelines for Facilitating Pedestrian Movements within Suburban Activity Centers (6A-52), and Bicycle Facility Planning (6A-55). In addition, an informal review of continuing education programs was made to determine whether there were any current courses on nonmotorized transportation.

The fourth chapter presents a syllabus for a course on nonmotorized transportation as might be taught in graduate school or for a continuing education program. The final chapter summarizes the reviews and makes recommendations for improvements.

The fourth chapter presents a syllabus for a course on nonmotorized transportation as might be taught in graduate school or for a continuing education program. The final chapter summarizes the reviews and makes recommendations for improvements.

2. Review of Existing Texts

A number of standard references and texts are used by transportation planners and engineers. This chapter will review existing general transportation references, which focus mostly on motorized vehicle transportation. The two most widely used undergraduate transportation engineering texts are also evaluated. It will then look at several texts and references concerned with nonmotorized transport. The first section provides a critical review of standard references and proposes some structural changes so that they may provide better coverage of pedestrian and bicyclist issues. The second section reviews other pedestrian and bicycle publications that may potentially serve as references. The third section reviews some literature covering residential streets, a study which helps integrate modes of travel on a certain class of the road system. Were the literature as comprehensive, a similar study could evaluate commercial areas. Obviously, in the scope of work of any project it would be impossible to review every transportation reference, or every book or article which covers bicycles or pedestrians as modes of transportation; thus, selections have been made. It is hoped that these choices are considered reasonable.

2.1 General Transportation Texts

Several specific references together form the backbone of transportation engineering, planning, and administration in the United States. The following fundamental references are critiqued in this section for their coverage of pedestrian and bicycle issues:

1) ***A Policy on the Geometric Design of Highways and Streets*** (AASHTO)

2) Transportation Planning Handbook (ITE) and ***Traffic Engineering Handbook*** (ITE)

3) Manual on Uniform Traffic Control Devices (FHWA)

4) Uniform Vehicle Code and Model Traffic Ordinance (NCUTLO)

5) Highway Capacity Manual (TRB)

6) Highway Engineering (Wright & Paquette)

7) Highway Engineering (Oglesby & Hicks)

2.1.1 *A Policy on Geometric Design of Highways and Streets*

1990, American Association of State Highway and Transportation Officials

A Policy on Geometric Design of Highways and Streets, or the "Green Book," forms the basis of highway and street geometric design guidelines throughout the United States, and as such holds a special place among references. Along with the ***Manual on Uniform Traffic Control Devices,*** and a few other documents, it has been adopted in whole as the wisdom of the transportation profession. Adherence to the Green Book provides at least partial liability protection for the professional, giving it a certain authority other references and texts do not have.

In the preface of the 1984 edition, the following is noted: ***"A Policy on Design of Urban Highways and Arterial Streets*** [AASHTO, 1973] contains materials on issues of urban planning and design that have not been replaced in this publication. Additional emphasis has been placed on the joint use of transportation corridors by pedestrians, cyclists, and public transit vehicles. Designers must recognize the implications of this sharing of transportation corridors. Designers are encouraged to consider not only vehicular movement, but also movement of people, distribution of goods, and provision of essential services. A more comprehensive transportation program is thereby emphasized."

First consideration of the pedestrian is given in Chapter II, "Design Controls and Criteria." The section on Pedestrians, the most comprehensive pedestrian coverage in the Green Book, is subdivided into discussions of General Characteristics, Physical Characteristics, Walkway Capacities, and Handicapped Pedestrian Characteristics. The conclusion regarding urban highways suggests that vehicular-pedestrian conflicts should be avoided or ameliorated; however, the recommendation is concerned primarily with the pedestrian's conflict with the vehicle rather than the vehicle conflicting with the pedestrian. All other discussion of pedestrians is cursory in the Green Book.

Chapter IV, "Cross-Section Elements," includes the basic warrant for sidewalks, which states that "As a general practice, sidewalks should be constructed along any street or highway not provided with shoulders, even though pedestrian traffic may be light." Later, in Chapter VI, "Collector Roads and Streets," it is stated that "Sidewalks should be provided on both sides of urban collector streets that are used for pedestrian access to schools, parks, shopping areas, and transit stops, and along all collectors in commercial areas. In residential areas, sidewalks are desirable on both sides of streets, but should be provided on at least one side of all collector streets." A similar statement is made in Chapter V, "Local Roads and Streets." Mention is made of placement of sidewalks and separation from the roadway as well as placement of bridges. Curb-cut ramps are recommended at crosswalks.

Chapter VII, "Rural and Urban Arterials," presents a one-page discussion of pedestrian facilities and street crossings.

A one-half page section on bicycle facilities follows the discussion of pedestrians in the chapter "Design Controls and Criteria." The reader is referred to the ***Guide for Development of New Bicycle Facilities,*** a booklet by AASHTO, most recently reissued in 199 1.

In the chapters on "Cross-Section Elements," "Local Roads and Streets," and "Rural and Urban Arterials," the reader is again referred to the above text.

Because of the Green Book's special significance as a policy reference and teaching aid, it might be appropriate to incorporate into the next edition of the Green Book the ***Guide for Development of New Bicycle Facilities*** and information concerning planning and design of facilities for pedestrians and bicyclists from ***A Policy on Design of Urban Highways and Arterial Streets*** that was not included in the 1991 edition. This inclusion is important particularly for the nonspecialist in human-powered transport, who may not have ready access to the referenced texts, and thus would ignore the subject of pedestrian and bicyclist facility planning and design altogether. The discussion of pedestrians is much more comprehensive than that of bicyclists, but is still an afterthought to the main body of the text.

The revision suggested above should be carefully edited to assure that there is proper coverage of the traditional geometric design aspects of both bicycle and pedestrian facilities including vertical alignment and grades, horizontal alignment and curves, superelevation, cross-sections, widths, and cross-slopes.

2.1.2.1 *Transportation and Traffic Engineering Handbook*

1982, Institute of Transportation Engineers

In 1982, the Institute of Transportation Engineers published the ***Transportation and Traffic Engineering Handbook*** (TTEH). Because of the complexity of revising the book as a single volume, its editorial board has decided to revise it as two texts, the first of which, the ***Traffic Engineering Handbook,*** has been released and is reviewed in section 2.1.2.2. The second is to be a ***Transportation Planning Handbook,*** which was not available for review. It is to this second book that the review below of the TTEH is most geared.

The ***Transportation and Traffic Engineering Handbook*** is a highly readable book divided into sections on various subjects. Chapters on six different modes are included: Air, Water, Railroad, Pipelines, Highway, and Transit. However, neither the Walking nor Bicycling modes are given their own chapters. They are covered as sections in several later chapters, however, and those chapters were reviewed.

The first mention of pedestrians is in Chapter 8, "Human Factors in Transportation." The topics in this section include an overview of safety, in particular children and the elderly. The literature is reviewed on the following subjects: Walking Rates, Gap Acceptance, Volume and Density, Observation of Regulations, Signals, Accident Characteristics, Pedestrians and Alcohol, Injuries, Sidewalks and Underpasses, Accident Countermeasures, and Accident Types.

Chapter 10, "Urban Travel Characteristics," discusses some typical pedestrian flows, trip length distribution, trip purposes, and trip rates. Again the discussion is short.

Chapter 17, "Traffic Studies," mentions generic pedestrian count studies, and outlines a methodology for studying street crossings near schools. The text ***A Program for School Crossing Protection*** [ITE, 1971] is referenced. The section on accident studies also considers the pedestrian and bicyclist as factors to be analyzed and designed for.

Chapter 18, "Transportation Safety," also notes pedestrian-vehicle conflicts, and states that "18 percent of motor-vehicle related deaths are pedestrian deaths."

Chapter 22, "Circulation in Major Activity Centers," provides a major focus on pedestrians in an urban environment. Reference is made to ***Pedestrian Planning and Design*** [Fruin, 1971], considering pedestrian Level of Service. The definition of Level of Service is density based, so that the quality of the trip is not considered, only the number of pedestrians per unit area. This chapter includes some discussion of pedestrian streets, a topical subject in 1982. In addition, the text, tables, and pictures provide coverage of automated pedestrian facilities such as moving sidewalks, elevators, and escalators. Concern of the activity center as a mode transfer location is the main focus of this chapter, with the pedestrian as at least one of the modes in the transfer.

Chapter 26, "Traffic Regulations," considers the pedestrian peripherally in the section on pedestrian-only streets. Part-time street closure to pedestrians is a subject of regulation which requires the consideration of the traffic engineer for vehicular traffic routing, including not only automobiles, but potentially transit and emergency vehicles.

As with pedestrians, some human factors of the bicyclist are discussed in Chapter 8. Reference is made to the study ***Bikeway Planning Criteria and Guidelines*** [ITE, 1972], but the discussion is quite brief.

Chapter 12, "Urban Transportation Planning," includes a section on bikeway planning. Two sources are noted: ***A Bikeway Criteria Digest*** [FHWA, 1977] and ***Planning and Design Criteria for Bikeways in California*** [FHWA, 1979]. The planning process is applied to bicycle facilities, posing pertinent questions on operational and implementational problems.

Chapter 19, "Geometric Design," has a section on Bikeways. Brief sections on Bikeway Options, Design Speed, Bikeway Widths, Grades, Stopping Sight Distance, Grade Separations, and Intersection Treatment are included. Some of this information is drawn from ***Safety and Locational Criteria for Bicycle Facilities*** [FHWA, 1976], and from the ***Guide for Bicycle Routes*** [AASHTO, 1974].

2.1.2.2 Traffic Engineering Handbook

1992, Institute of Transportation Engineers

This first chapter of the ***Traffic Engineering Handbook*** (TEH) is devoted to pedestrian and driver characteristics. The section on pedestrian characteristics is drawn from safety studies, behavior studies, Fruin's ***Pedestrian Planning and Design,*** and Pushkarev and Zupan's ***Urban Space for Pedestrians.*** Topics covered include signals, safety, nighttime conditions, social factors, the handicapped, children, and the elderly. The focus on pedestrian characteristics is stronger than the TTEH. Bicyclist characteristics are also noted.

Chapter 3, "Traffic Studies," devotes a page to pedestrian studies, drawn from the ***Manual of Traffic Engineering Studies.*** Chapter 5, "Operational Aspects of Highway Capacity," drawn from the ***Highway Capacity Manual,*** like the HCM, gives little coverage to the pedestrian and bicyclist. Chapter 6, "Roadway Geometric Design," devotes four pages to design of bicycle and pedestrian facilities, drawn from the AASHTO ***Guide for the Development of New Bicycle Facilities*** and ***A Policy on the Geometric Design of Highways and Streets.*** Pedestrian signals are discussed in Chapter 9, "Traffic Signals," drawn from ***the Manual on Uniform Traffic Control Devices.*** Chapter 11, "Traffic Regulations," devotes two pages to bicycle lanes and bikeways and to pedestrian-only streets. These are drawn from the ***Bikeway Criteria Digest and Planning and Design Criteria for Bikeways in California.***

2.1.2.3 Thoughts on a *Transportation Planning Handbook*

The TTEH serves the purpose of providing the transportation professional with a concise review of current research on various topics in transportation. Sections on various modes, structured similarly to U.S. Department of Transportation administrations, are included. However, as with the Federal administrative structure, the walking and bicycling modes are not given equal standing, and are included only as subsections of other chapters. There are certainly enough issues concerning pedestrian and bicycle transportation that chapters should be provided in similar style and structure to the chapters on the other modes. To provide better design guidelines, summaries of ***Residential Street Design and Traffic Control,*** and ***Transportation and Development*** might further enhance the ***Transportation Planning Handbook*** without the need for much additional work on the part of the editors.

2.1.3 *Manual on Uniform Traffic Control Devices*

1938, Federal Highway Administration

The ***Manual on Uniform Traffic Control Devices*** (MUTCD) provides standards for the placement of "signs, signals, markings, and devices placed on, over, or adjacent to a street or highway by authority of a public body or official having jurisdiction to regulate, warn, or guide traffic." [MUTCD, 1988]

Part III, "Markings," includes a section, 3B-19, on crosswalk marking warrants and guidelines. Part IV, "Signals," has several sections and subsections which are concerned with pedestrian movement. Section 4B covers Traffic Control Signals. Sections 4B-28, Provisions for Pedestrians, and 4B-29, Pedestrian Detectors, outline pedestrian signals, or the use by pedestrians of vehicle signals. Section 4C, Signal Warrants, contains three warrants relevant to pedestrian movement: Warrant 3–minimum pedestrian volume; Warrant 4–school crossing; and Warrant 6–accident experience. Section 4D is devoted to Pedestrian Signals.

Part V, "Islands," includes Section 5A-4 which is concerned with Pedestrian Refuge Islands. This mentions some criteria for determining where one may place pedestrian islands, but offers no requirements or warrants for such.

Part VII, "Traffic Controls for School Areas," discusses several topics relating to the child pedestrian's use of the transport system. A method for developing a school route plan is outlined. School crossing criteria are also discussed. Separate sections on school crossing signs, markings, and signals are included in this chapter.

Part IX is titled "Traffic Controls for Bicycle Facilities." Many of the signs are derived from standard highway signs. Section B includes signs specific to bikeways, and for use by bicyclists on shared facilities. Standards for lane and object markings are presented in Section C. Section D notes that signals may be designed for the bicyclist, and that signal timings may be different to accommodate bicycles.

Without getting into the debate over appropriate warrants for particular signs and devices, it can be stated that some more specificity in warrants for various traffic control devices relating to pedestrians and bicyclists, may be helpful. For instance, warrants for different types of bicycle facilities based on volume would help engineers determine where these are appropriate and necessary.

There may be a need for standard guide signs for pedestrians and bicyclists of different scale and style than those used for motorized vehicles. Those signs are not covered in the MUTCD. These are particularly pertinent in areas with large numbers of tourists or infrequent visitors. Warrants for traffic control devices related to creating residential streets and pedestrian oriented commercial areas would further promote the adoption of such techniques.

2.1.4 Uniform Vehicle Code and Model Traffic Ordinance

1987, National Committee on Uniform Traffic Laws and Ordinances

This reference serves to provide a basis for a comprehensive and uniform set of regulations for State traffic and motor vehicle laws. While the "Uniform Vehicle Code" (UVC) purports in its title to be a vehicle code, properly it should be considered a motor vehicle code, as nonmotorized vehicles are essentially not considered except as they impact the motor vehicle.

The UVC is structured into 18 chapters which are subdivided into numerous articles. Three chapters are relevant to the transportation professional regarding pedestrians and bicyclists.

The first chapter is titled "Words and Phrases Defined." These definitions need to be understood by those concerned with pedestrians and bicycles. Several key definitions are restated in Table 1.

Chapter 11, "Rules of the Road," contains Article V, "Pedestrians Rights and Duties," which gives the right of way to pedestrians on sidewalks and crosswalks, but to the vehicle on the roadway. While the "safety zone" prohibits vehicles, no provision is made for the *woonerf* or other type of shared areas. While the UVC encourages experimentation that promotes the safe and efficient use of highways, the formulation of regulations concerned with these joint use facilities may assist in their adoption.

Article XII of Chapter 11 concerns "Operation of Bicycles, Other Human Powered Vehicles, and Mopeds." The section considers bicycles to have the same rights and obligations as motor vehicles, although bicycles are expected to generally travel on the right when traveling below the normal vehicle speed. When bicycles are on sidewalks or crosswalks, they must yield to pedestrians.

Chapter 12, "Equipment of Vehicles," contains Article VII, "Bicycles," which should be known by any bicycle user. These include requirements for brakes, and for reflectors at all times and lights when the vehicle is used at night. The Model Traffic Ordinance contains a section on licensing of "pedalcycles," but otherwise is not different from the UVC in its coverage of pedestrians and bicycles.

Ironically, although pedestrians and bicycles historically predate motorized vehicles, in both the Uniform Vehicle Code and the Model Traffic Ordinance, motor vehicles are given precedence on the road.

TABLE 1: Definitions in the *Uniform Vehicle Code and Model Traffic Ordinance*

Bicycle—Every vehicle propelled solely by human power upon which any person may ride, having two tandem wheels, except scooters and similar devices. (Section 1-1 05)

Crosswalk—(a) That part of a roadway at an intersection included within the connections of lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or, in the absence of curbs, from the edges of the traversable roadway; and in the absence of a sidewalk on one side of the roadway, that part of the roadway included within the extension of the lateral lines of the existing sidewalks at right angles to the centerline.

(b) Any portion of a roadway at an interaction or elsewhere distinctly indicated for pedestrian crossing by lines or other markings on the surface. (1-1 12)

Human Powered Vehicle—Every vehicle designed to be moved solely by human power. (1-130)

Pedalcycle—The term pedalcycle includes (1) every vehicle propelled solely by human power upon which any person may ride, having two tandem wheels, except scooters and similar devices; and (2) every vehicle propelled solely by human power upon which any adult person may ride, having three wheels. (31-220)

Pedestrian—Any person afoot. (1-1 54)

Roadway—That portion of a highway improved, designed, or ordinarily used for vehicular traffic, exclusive of the sidewalk, berm, or shoulder even though such sidewalk, berm, or shoulder is used by persons riding bicycles or other human powered vehicles. In the event a highway [street] includes two or more separate roadways, the term roadway as used herein shall refer to any such roadway separately but not to all such roadways collectively. (1-169)

Safety Zone—The area or space officially set apart within a roadway for the exclusive use of pedestrians and which is protected or is so marked or indicated by official traffic control devices as to be plainly visible at all times while set apart as a safety zone. (1-170)

Sidewalk—That portion of a street [highway] between the curb lines or the lateral lines of a roadway, and the adjacent property lines, intended for use by pedestrians. (1-175)

Street [Highway]—The entire width between boundary lines of every way publicly maintained when any part thereof is open to the use of the public for the purposes of vehicular traffic. (1-183 [1-128])

2.1.5 The Highway Capacity Manual-Special Report 209

1935, Transportation Research Board

The Highway Capacity Manual (HCM) is a handbook providing the methodology for conducting capacity analyses on a variety of surface transportation facilities. One chapter of this 14-chapter reference is devoted to pedestrians and one to bicycles.

Chapter 13 of the Manual concerns itself with pedestrians. Following the structure of the HCM, it is divided into three sections: Introduction, Methodology, and Application.

The Introduction brings out key terminology and relationships that are necessary for analysis of pedestrian flows. The principles of flow, including speed-density, flow-density, and speed-flow, are drawn from ***Urban Space for Pedestrians*** [Zupan and Pushkarev, 1975]. The subsection on effective walkway width is an attempt to understand capacity, as the concepts useful for vehicular movement do not apply. Also noted is the impact of pedestrian type, particularly on speed.

The Methodology section, as throughout the HCM, is concerned primarily with Level of Service. The Level of Service definitions concern primarily directly quantifiable attributes such as density, flow, and speed. The other factors noted in the first section-comfort, convenience, safety, security, and economy—are not considered here. Walkways, platoons, queuing areas, crosswalks, and street corners are discussed.

The Application section provides worksheets for computing the quantitative level of service discussed in the methodology section.

Chapter 13, "Pedestrians," provides a fairly comprehensive discussion of pedestrian capacity and quantitative Level of Service. Inclusion of methods for quantifying the other Quality of Service measures would be useful, although the research here is much more behavioral than the other fields covered by the HCM.

Chapter 14, "Bicycles," seems an afterthought. The chapter is four pages long, and concerns itself almost totally with the impact of bicycles on motorized vehicle flow. Although the impact of bicycles on motorized flow may be important, the converse, or impact of motorized flow on bicycles, is also worth understanding. No discussion of bicycle capacity or bicycle level of service is presented.

"Transportation Research Circular" Number 37 1 [TRB, June 199 1] covers "A Program of Research in Highway Capacity" which may rectify some of the problems in the 1985 ***Highway Capacity Manual*** by the next edition, scheduled for the year 2000. Two of the twenty-one projects relate to bicycles, "Uninterrupted Bicycle Flow Characteristics" (Study 20) and "Revision of HCM Chapter 14: Bicycles" (Study 21). One study relates to Pedestrians, "Revision of HCM Chapter 13: Pedestrians" (Study 19). Just by noting the position in the ranking of these studies,

near or at the bottom, it can be inferred that the profession still does not give high priority to these modes. Research on Bicycles is expected to be funded for about $150,000, and on Pedestrians for $50,000, which together are 7 percent of the $3.15 million dollars allocated. The updates discussed in the following paragraphs will be made.

> ***The chapter on pedestrians will require some rewriting to incorporate findings of recent studies on crosswalk and comer analyses and some coordination with Chapter 9 regarding pedestrian effects on right turn movement saturation rates and lost times. A major limitation of the present chapter is that the present method is based overwhelmingly on New York City data. Project 19 is meant to address some of these deficiencies.***
>
> ***The principles of bicycle flow are not well known. Project 20 is meant to enhance the state of knowledge of the basic principles and relationships of uninterrupted flow facilities. As a result, the bicycle chapter will require some rewriting (project 21) and a small-scale study of uninterrupted bicycle flow. [TRB, 1991]***

2.1.6 *Highway Engineering, Fifth Edition*

1987, Paul Wright and Radnor Paquette

This book, published by Wiley, is one of the most popular undergraduate texts in transportation engineering. As suggested by the title, it is geared toward highway design and geometrics, but does have some coverage of the pedestrian and bicyclist. It should not, however, be considered suitable as a text on the subject.

Five pages of the 7 17-page text are devoted to the Planning and Design of Bicycle Facilities. This section is consistent with ASCE's Bicycle Planning Handbook and AASHTO guidelines, though much abbreviated.

No more attention to the pedestrian is paid. Both the section on pedestrian characteristics and on planning and design for pedestrians summarize Fruin's ***Pedestrian Planning and Design.*** All other mention of pedestrians is cursory.

This text, while providing little coverage of the topic, is at least not negative toward pedestrians and bicyclists concerning the training of transportation professionals. The same cannot be said of the next text.

2.1.7 Highway Engineering, Fourth Edition

1982, Clarkson H. Oglesby and R. Gary Hicks

Though titled the same as the previous book and ironically published by the same company, this text has a different lineage. It is intended for the same market, and is a widely used text for undergraduate transportation engineering. Again this text cannot be considered suitable for coverage of pedestrian and bicycle issues, and is in some respects hostile to the pedestrian and bicyclist.

The section on highway accidents notes the high accident rates involving bicyclists and pedestrians, and blames the victims for their carelessness. No mention is made of design which can prevent accidents in the first place, such as restricting the speeds of autos, provision of exclusive rights-of-ways for nonmotorized transportation, and good visibility.

The section on special design problems states the discussion of the mix between pedestrian, bicycles, and motor vehicles is beyond the scope of the book. A mention is made of underpasses and overpasses. It is suggested that pedestrians, much like farm animals, should be fenced so that they cannot intrude on the highway. “Fences for this purpose are really to protect people from their own folly.”

The text was originally written in 1954, and was last updated in 1983. The ideas presented on these topics are outdated and very short on detail and explanation. The use of this text for coverage of pedestrian and bicyclist issues is inappropriate.

2.2 Specific Bicycle Reference Materials Available

The second section reviews references which are geared specifically towards bicycles. Reams of reports have been written on bicycle transportation; most are specialized reports or site specific. This review is concerned with those which could serve as potential references or course supplements. Those reviewed here include:

1) ***Guide for the Development of Bicycle Facilities*** (AASHTO)

2) ***Bicycle Transportation: A Civil Engineer’s Notebook for Bicycle Facilities*** (ASCE)

3) ***Bicycle Transit: Its Planning and Design,*** Balshone, Deering, McCarl

4) ***Bicycles and Public Transportation,*** Replogle

5) ***Bicycling, Transportation and Energy: A Handbook for Planners,*** Jordan

6) ***A Bikeway Criteria Digest*** (USDOT)

7) ***Bicycle Transportation, Forester***

2.2.1 *Guide for Development of Bicycle Facilities*

(1991) American Association of State Highway and Transportation Officials

As referenced in ***A Policy on the Geometric Design of Highways and Streets,*** or the "Green Book," this document serves as the principal guide for geometric design of bicycle facilities, both shared and separated. The booklet is broken into three sections: "Planning," "Design," and "Operations and Maintenance."

The chapter on "Planning" develops the scope of the problem, development of bicycle facilities, and planning for bicycle travel. Most bicycle travel does not occur on designated facilities, so the design of public streets to safely accommodate the bicyclist is an important point. The planning process, including "Inventory of Existing Conditions," "Analysis of Improvements," and "Criteria for Selection of a Facility," is discussed in this chapter.

The "Design" chapter is composed of three sections: Roadway Improvements, Bicycle Paths, and Supplemental Facilities. Roadway Improvements which are explicitly considered and for which design guidelines are given include: Drainage Grates, Railroad Crossings, Pavements, Traffic Control Devices, Shoulders, Wide Curb Lanes, Bicycle Route Designation, and Bicycle Lanes.

The section "Bicycle Paths" gives quite specific geometric design criteria. Topics in this section include: Width and Clearance, Design Speed, Horizontal Alignment and Superelevation, Grade, Sight Distance, Intersection, Signing and Marking, Pavement Structure, Structures, Drainage, Lighting, Restriction of Motor Vehicle Traffic, and Multi-Use paths.

Supplemental facilities to service the bicyclist are noted in a third section. In particular, parking, but also multiple mode use, and bicycle route maps are discussed.

A brief chapter noting some possible concerns for the operating agency is included in the booklet. Cleaning of the road surface and pruning areas adjacent to paths of plant growth are the two primary suggestions.

This booklet in and of itself meets its objective, although as noted in the previous section of the report, it would be more useful if it were distributed as part of the AASHTO Green Book, or better, incorporated within that reference.

2.2.2 Bicycle Transportation: A Civil Engineer's Notebook for Bicycle Facilities

1980, American Society of Civil Engineers

This 187-page report was prepared by the Bicycle Transportation Committee of the Urban Transportation Division. Composed of twelve chapters by five authors, it is the most comprehensive design guide on bicycle transportation that has been reviewed here. It was intended to be "a concise compilation of the best material now available in the United States."

The first chapter reviews "Facility Planning." A discussion of Interest Groups in the Decision-Making Process frames the problems of implementation of bicycle plans. The section on "Technical Planning" includes functional classification and bicycle storage which comes in large part from ***Planting and Design Criteria for Bikeways in California*** [Caltrans, 1978]. The section on Demand Forecasting is drawn from ***Bikeway Planning and Policy Guidelines for New York City*** [Kraft and Leland, 1978]. Demand forecasts are needed for new facilities, and the structure of the analysis techniques presented is quite similar to conventional transportation demand analysis. It is noted that capacity is not generally a constraint once it is provided in minimal form.

The second chapter, "Landscaping," is weaker, providing only a general overview of landscaping in relation to bicycle facilities.

The third chapter, "Geometrics," is a very good prescriptive guide for engineering of new bicycle facilities. Descriptions of design guidelines along with illustrations for each of the functional classes are provided. Again, the chapter is drawn from [Caltrans, 1978] and ***Bikeway Design*** [Oregon State Highway Division, 1974]. Topics include widths, grades, curvature, sight distance, and placement.

Chapters IV, V, and VI are on "Structures," "Pavement," and "Drainage," respectively. They are quite brief and could easily be combined. A few normative guides to design are presented regarding the road surface.

Chapter VII, "Traffic Controls," is drawn heavily from the ***Manual on Uniform Traffic Control Devices.*** It includes discussion of sign, signal, and markings placement, and a number of the general rules presented in the MUTCD. [FHWA, 1987]

Chapter VIII, "Amenities," Chapter IX, "Lighting," and Chapter X, "Parking," again go together with Chapter III, "Landscaping," as several of the peripheral but important topics. These chapters are sensible, and not different from the way the subject may be treated concerning the automobile.

Chapter XI, "Maintenance and Security," is necessary, but the subject is not given due treatment.

Chapter XII is a glossary, and this is followed by a comprehensive bibliography.

ASCE's ***Bicycle Transportation*** provides the nucleus of text materials that should be used in any course covering bicycle transportation as a separate topic at either the undergraduate or graduate level. The material may not be enough for a full three credit hour course, but is certainly substantial enough for a seminar or as part of a course on nonmotorized transportation.

2.2.3 Bicycle Transit: Ifs Planning and Design

1975, Balshone, Deering, and McCarl

Bicycle Transit is a textbook in the Praeger Design and Environmental Planning Series. It is clearly designed for the planner rather than the engineer, and places special emphases on bicycle history and landscaping that are not found in the other reviewed works.

The first chapter traces the rise, decline, and rebirth of the bicycle movement through American history. A number of illustrations of the historical evolution of the bicycle as a vehicle are provided.

The second chapter reviews bicycle planning. The planning concept posited by the authors is that of the "Cell," which is defined as a "Distinct geographic area within a community which has common transportation needs." This model appears mostly speculative and fails to sufficiently deal with the interconnections between communities.

Chapter 3, "Design," is well illustrated. The audience would seem to be urban designers, with the abundance of trees in all of the figures. Evaluation techniques for using abandoned or underutilized rights-of-way for bicycles are presented. A discussion of "Mixed-Mode Systems," including bicycles on other vehicles and bicycle access to public transit, is presented. Most comprehensive is the section on Planting. Plants as separators and specifics on the types of plants to use give the designer more information than any other source reviewed on this topic. The section on Engineering is similar in many respects to the other works. However, more impressive are the illustrations provided on cross-sections and various design elements.

Chapter 4, "Legislation," is sparse and now outdated. It provides the status of then current laws, and a discussion of some attempts to prevent bicycles from using other roadways. Chapter 5, "Prospects for the Future," concludes the work without saying much. A quite comprehensive bibliography is presented.

Sections of this work could supplement a course in bicycle transportation planning and engineering; however, in and of itself it is not complete enough for engineering training.

2.2.4 Bicycles and Public Transportation

1983, Michael Replogle

This work is unique with its intensive treatment of bicycle access to transit. The author notes that this mode of transport is for the most part negligible in the United States; however, in Japan and Western Europe, this mode is significant and, for that reason, may be able to serve Americans in the future. This work is filled with a wealth of statistics and numbers on bicycle usage throughout the world. Those tables provide the planner with a framework for asking questions on the state of current demand.

The work is divided into nine chapters. The first, "The Evolution of Transit Access," contains some historical review as well as contemporary summary of transit access in Europe and Japan. Later chapters delve into more depth on this topic.

The second chapter, "Access to Public Transportation: An Overview," is the most general of the chapters, and may be the most useful in a mass transit planning class. Access to transit may be as important as the transit service in determining demand and utility, and the focus here raises some pertinent points. The paucity of current bicycle access to transit in the United States is noted and contrasted with the situation in other countries.

The third chapter, "Bicycles and Rail Transportation in Japan," and the fourth, on "Western Europe," give the American reader insight into how the transportation problem is dealt with by America's major economic competitors. This kind of international view is all too often lacking in other transportation literature, with only research and application in English speaking countries being noted. A great deal of focus in both chapters is placed on bicycle storage at transit stations. These two chapters contrast sharply with Chapter 5, "Bicycle Access to American Public Transportation." Several sites with notable bicycle access to transit are reported, but these are overwhelmed by the absence elsewhere.

Chapter 6, "Bicycles on Railways," and Chapter 7, "Bikes-on-Buses," review the experience of transit agencies in these programs which might encourage both bicycle and transit usage. These programs were concluded to be most practical in off-peak periods, as during the peak, vehicle capacity problems makes them operationally difficult.

Chapter 8, "Factors Affecting Bike and Ride Travel," discusses the conditions impacting and influencing bike and ride travel demand. Many of these are generic to the bicycle as a transportation mode, others are common to transit access. These factors are compared internationally, and can be used to show conditions where bike and ride works. Some factors may be endemic to U.S. society including a high crime rate, level of auto ownership, and cultural conditions. Others, such as access conditions and the provision of bicycle parking, can be more easily improved to encourage bicycle transportation.

Chapter 9, "Planning Guidelines for Bike and Ride Development," discusses areas where bike and ride is most promising and how to leverage the most bicycle usage there.

In short, this book contains supplementary material which is applicable to either a transit planning class or to a course on bicycle or nonmotorized transportation. The international perspective is intriguing, and would benefit much other planning literature. Unfortunately, many of the statistics in the book, while valid, are not current. As with so much of the formal literature, it is dated by its use of studies and concerns which were current at the time.

2.2.5 Bicycling, Transportation, and Energy: A Handbook for Planners

1984, Gihon Jordan (published by the author)

Periodically, America focuses on energy use and efficiency as a societal goal. With the move towards free markets in energy and the international decartelization of energy supply, we hope that fuel shortages are a footnote to history, and that proper pricing of commodities will regulate their use and encourage rational conservation measures. This book provides an analysis of the energy consumption of bicycles which is unique, and some prescriptive techniques for promoting bicycle usage which are better presented elsewhere, and which will not be reviewed.

The analysis of automobile energy use is methodologically problematic. The author attempts to provide statistics showing energy use by bicycles and automobiles, but neglects to show the benefits that accrue by having greater destination opportunities with additional fuel consumption. The author divides the analysis between direct and indirect energy consumption. He is admittedly on shaky ground with analysis of indirect energy use, that for construction, maintenance, and operation of the transportation system. Given the variability in the numbers, it is probably sufficient to state the proposition that bicycles use a great deal less energy than cars and just leave it at that.

This book is likely not useful as a reference for transportation planners or engineers, except in providing a source for the "political number," which can be used as a weapon in policy debates.

2.2.6 A Bikeway Criteria Digest: The ABCD's of Bikeways

1977, USDOT, Federal Highway Administration

A *Bikeway Criteria Digest* is one of the most widely cited bicycle manuals. It is divided into four "steps" associated with the four letters forming the abbreviation of the work's title, which are Planning, Location, Design, and Operation.

The first two sections, "Planning" and "Location," would well supplement the ASCE Bicycle Handbook. These two sections pose questions about the nature of the area and desired

plan and present qualities that should be met in good design. It is not a how-to guide, but does help the planner ask appropriate questions, which can only be answered with local data.

The third section, "Design," is very similar to other bicycle engineering design sections, some of which are drawn from this or from the same sources on which this is based. This section is less complete than the Bicycle Handbook.

The fourth section, "Operations," is also similar to the Bicycle Handbook, and discusses topics drawn from the MUTCD.

This is a well designed handbook, although it could stand to be updated, expanded, and combined with a more comprehensive text. It is only a guide to bikeways, and does not cover other bicycle transportation issues.

2.2.7 Bicycle Transportation

1983, John Forester

Originally published as ***Cycling Transportation Engineering*** in 1977, this book provides little guidance to the design of specific bicycle facilities because the author argues against them. Forester strenuously puts forward the position that bicycles are vehicles and that bicyclists should obey the same rules of the road as drivers and should assume the same privileges. He makes the point that bicyclists should not consider themselves inferior to the automobile driver because the inferior position is more dangerous than assuming equal standing. The author's other book, ***Effective Cycling,*** discusses this in more depth. This position is in direct opposition to much of the other literature on the subject, although it is soundly based for the existing bicycle commuting population primarily composed of young men.

The work is divided into 24 chapters, which may be too long considering the subject material. The first chapter, "Systematic Traffic Law," introduces the author's argument about the legal standing of bicycles as vehicles and why they should use the same road facility as the automobile. Separate facilities, such as bike lanes, lead to more conflicting movements, particularly at intersections, which is clearly more dangerous.

The second chapter, "Parameters of Practical Bicycling," delves into the conventional planning topics of distance, origins and destinations, capacity, traffic flow, and the weather as factors influencing the decision to ride bicycles. The third chapter, "History and Demographics," elaborates on who rides bicycles, and strongly discounts the examples of Europe and Japan by noting that as incomes rise in those areas, individuals replace labor (pedaling a bicycle) with capital (driving an automobile). This is a well-made point.

Chapter 4, "Cyclist Proficiency," argues for the author's position on how to properly ride a bicycle in mixed traffic, discussed in his ***Effective Cycling.*** Chapter 5, "Cycling Accidents,"

discusses for 50 pages the types and causes of accidents. This is some of the best depth on the subject available, and would be a good supplement to a traffic engineering course.

The sixth chapter, "Two Views of Cycling," drives home the author's viewpoint about the bicycle as a vehicle of equal standing. The seventh chapter, "The Effect of Cycling on Traffic," suggests that bicycles don't interfere with auto traffic so much as auto traffic interferes with itself. This section is fairly weak. Chapter 8, "The Effects of Bikeways on Traffic," discusses the hazards associated with bike lanes and the increase in crossing and conflicting movements compared with integrated traffic.

Forester's Chapter 9, "Flow of Cycle Traffic," strongly criticizes the FHWA's ***Safety and Location Criteria for Bicycle Facilities: Final Report*** of 1976 for several errors in analysis. This chapter also suggests that passing room be used as a measure of Level of Service for bicycles.

The tenth chapter, "The Economics of Cycling," enters the dubious fray in the attempt to compare the costs of various modes of transportation. As with Gihon Jordan's ***Bicycling Transportation and Energy,*** it is clear that bicycling is cheaper in economic terms than driving assuming a zero value of human time and energy, and this issue does not need further discussion. The eleventh chapter, "Cycling Organizations," discusses in some depth the politics within various bicycling organizations, including those which advocate separate bicycle facilities. Forester criticizes the membership of these organizations as not being true cyclists, but rather haters of the automobile.

Chapter 12, "Educational Programs," takes to task the current teaching of children of how to ride bicycles. Forester puts forth ***Effective Cycling*** again. Chapter 13, "The Practice of Cycling Transportation Engineering," discusses the problems of the cyclist and of conventional planning.

Chapter 14, "A Recommended Cycling Transportation Program," and Chapter 17, "Roads," would also well supplement a traffic engineering or highway engineering course. The recommended program would let cyclists report problems on the road system rather than having "professionals" determine areas that need repairs. Because there are so few cyclists, any money spent would best improve roads they actually use. Forester would also eliminate anticycling Government practices, such as bans of bicycles on certain roads. "Roads" discusses the need for wider than standard right lanes on roads so that bicycles can ride and still be overtaken by automobiles when necessary without dangerous maneuvers. The author opposes intersection channelization by vehicle type, suggesting that this would conflict with channelization by direction (or turn). Intersection lanes should not be extra wide because overtaking at intersections is dangerous.

Chapter 15, "Changing Government Policy," Chapter 16, "Law Enforcement," Chapter 18, "Bicycle Programs," Chapter 19, "Improving Bicycling Facilities," and Chapter 20, "Changing Bicycling Traffic Law," discuss in more depth earlier points. Chapter 21, "Standards, Specifications, and Regulations for Bicycles," suggests removing most special rules for bicycles. Chapter 22, "Nighttime Protective Equipment," argues for headlamp requirements during night

riding and states that using only reflectors is ineffective, which is why they are not used as sole means of lighting on autos. Chapter 23 discusses "Maps." Chapter 24 concludes the book.

In general this is a well written book with interesting ideas that are mostly pertinent to planners and policymakers. It is sometimes too strident, particularly appearing so to the uninitiated, which detracts from some quite valid observations. Three chapters, "Cycling Accidents," "A Recommended Cycling Transportation Program," and "Roads," would make excellent supplementary material to a traffic or highway engineering course.

2.3 Specific Pedestrian Reference Materials Available

This section covers texts with a particular emphasis on pedestrian transportation. Again, a great deal of material has been collected on pedestrian transportation. That which is reviewed here essentially consists of those that offer the potential to be references for training of transportation professionals. These include:

1) ***Pedestrian Planning and Design,*** Fruin

2) ***Urban Space for Pedestrians,*** Pushkarev and Zupan

3) ***A Pedestrian Planning Procedures Manual,*** RTKL and Associates

4) ***Walk Alert: National Pedestrian Safety Program,*** National Safety Council in Cooperation with FHWA and NHTSA

5) ***Synthesis of Safety Research: Pedestrians,*** Zegeer, FHWA

6) ***Planning, Design, and Maintenance of Pedestrian Facilities,*** Bowman, Fruin, and Zegeer, FHWA

2.3.1 *Pedestrian Planning and Design*

1971, John J. Fruin

This book is one of the two standard references in pedestrian specific planning and design, with Pushkarev and Zupan being the other. This 200-page work is divided into eight chapters. This text has the potential of serving as a reference for pedestrian specific transportation coursework.

The first chapter is an introduction entitled "Pedestrian Man." This section includes a history of man as a pedestrian, and cries out against current conditions facing the person who chooses or is forced to walk. Pedestrian safety and the plight of the handicapped are two special topics included. His noting of the problem of inconsistent signing covering the pedestrian

throughout the country has been ameliorated in large part by the more recent ***Manual on Uniform Traffic Control Devices.*** However, the problem of inconsistent laws and practices nationally, which Fruin identifies, remains.

Chapter 2, entitled "Human Characteristics Related to Pedestrian Design," is a human factors approach often lacking in transportation literature. This section is perhaps as appropriate to the architect as to the engineer and planner because so much of the crowding problem occurs within structures which are inadequately designed. The "body ellipse" analysis is very useful, as are the diagrams and discussions of walking and climbing.

"Traffic and Space Characteristics of Pedestrians," Chapter 3, applies traffic flow methodology to the movement of pedestrians. This section may be as appropriate as supplementary material to a traffic flow theory course as to a pedestrian design course. Walkways, stairs, escalators, elevators, queues, and doorways are all included.

Chapter 4 provides capacity based "Level of Service" (LOS) conditions for pedestrians in various environments. As with motorized traffic LOS, capacity is not the only basis for judgement. Circuity and trip quality are some of the important factors which are not included in these LOS measures. The LOS discussion provided here is necessary, but not sufficient, for understanding pedestrian trip quality. Chapter 5, "Pedestrian Movers," describes various mechanical devices for moving pedestrians, and their capacities and design constraints for planning and architectural purposes.

Chapter 6, "Elements of Pedestrian Planning," applies the standard rational planning methodology to pedestrian planning. Transportation concepts such as goals and objectives, hierarchy of movement, data collection, and forecasting are discussed. The data collection section is particularly dated. Fruin favors separation of modes through skyway or underground systems and through auto restricted zones. These concepts have recently fallen out of favor among architects and planners, although they may again come back in the future. Chapter 7, "Elements of Pedestrian Design," provides a capacity and LOS-based design methodology for many of the elements discussed above. This section is numeric, and could be quite useful in an engineering course. Chapter 8, "New Developments in Planned Pedestrian Environments," is now dated. It provides some examples of pedestrian only areas.

Chapters 2 through 7 of this book are still relevant enough to form the nucleus of text material for a course on the topic of pedestrian planning and design. Although it could stand to be updated, in its 197 1 form it sets the standard for engineering analysis of pedestrian LOS needs. As a reference on the topic, it is similar to Zupan and Pushkarev.

2.3.2 Urban Space for Pedestrians

1975, Pushkarev and Zupan

Urban Space for Pedestrians was published as a report of the Regional Plan Association of New York. It is larger and more ambitious than its predecessor ***Pedestrian Planning and Design*** [Fruin, 1971]. This book is divided into four chapters. Overall the book provides good coverage of the study of how much pedestrian space is needed. However, the book is dated and highly focused on the atypical Manhattan. Any updates of this topic should include needs in suburban centers and smaller cities and towns.

Chapter 1, "Urban Space: A Framework for Analysis," analyzes the allocation of space in cities to their various uses, for transportation and nontransportation, indoor and outdoor, commercial and residential. After developing a structure, a focus is placed on pedestrian space, with the history of space utilization discussed in some depth. The end of this chapter segues into travel demand analysis and determination of required pedestrian space.

Chapter 2, "Pedestrian Travel Demand," is further divided into two sections on different methods for estimating demand. The first is a modification of the multistep conventional transportation modeling process. The second is a more operational approach relying on provision of space and counts. Both techniques are weak and warrant further research. Development of a Pedestrian Transportation Modeling Approach including supply as a factor in demand and considering relationships between modes is an area of further study. The ***Pedestrian Planning Procedures Manual,*** reviewed next, attempts to cover this topic.

Chapter 3, "Pedestrian Space Requirements," summarizes the research on pedestrian flow and Level of Service. The quantitative relationship between space, speed, flow, and density is studied. This is the most analytical chapter, and would probably stand mostly unchanged in content today.

Chapter 4, "Implications for Design," is prescriptive in tone, and suggests the conclusion that expanding downtown pedestrian space at the expense of motor vehicles will cause only minor disruptions to traffic because of behavior changes. The conclusions drawn about an urban center cannot be assumed to be successful in small town and suburban environments.

This book has much to offer, but falls short of serving as an ideal textbook on the subject of pedestrian transportation. Its presentation is not in the form of a textbook, but rather a planning document, although much of the content would be at home in a text. The structure could stand to be reordered at the subchapter level, although the chapter topics themselves seem reasonable. A more generalized work would better serve transportation professionals.

2.3.3 A Pedestrian Planning Procedures Manual

1978, RTKL and Associates for the Federal Highway Administration

A ***Pedestrian Planning Procedures Manual*** is a report to the Federal Highway Administration which effectively applies the Urban Transportation Planning, and Modeling Process to pedestrian systems. The book is organized more as a report than a text, which hurts its utility as a course supplement. Volume 1, the Overview, is divided into four sections.

The first section relates pedestrian planning to the general context in land use/transportation planning process. It discusses the need for pedestrian planning. As with the two previous books, this volume is particularly focused on the urban site, not covering suburban activity centers or residential areas.

The second section looks more fully at the need for a pedestrian planning process. This section discusses cost/benefit and travel demand theory in brief.

The third section is the heart of the Manual. The Overview section divides the pedestrian planning process into a 27-step method which is similar to the UTPS. Two phases are defined, demand estimation and network design. Unfortunately, no feedback between the phases is provided. The specific rates and application are presented in the later volumes.

This document is better at describing the pedestrian planning process than is ***Urban Space for Pedestrians,*** but is not current with state of the art, particularly in mode choice modeling which is necessary for integrating the pedestrian model within general travel demand models. Because of its purpose, the book is also not formulated as a text, but more as a manual. Thus theory, while covered, is not fully developed.

2.3.4 Walk Alert: National Pedestrian Safety Program

1989, National Safety Council in association with National Highway Traffic Safety Administration and Federal Highway Administration

Walk Alert is a document prepared by the National Safety Council under a contract from the Federal Highway Administration. The first four sections deal with defining the ***Walk Alert*** program, describing how to use the program guide and characteristics of pedestrian accidents. Section 5 is a checklist for pedestrian safety and Section 6 describes special concerns of alcohol, seeing and being seen, rural pedestrian safety, and railroad grade crossings.

Section 7 discusses education from pre-school to older adults in detail as a community guide. Engineering and facility design are covered in Section 8, including sidewalks, bus stop location, physical barriers, facilities for disabled and elderly, pedestrian signals, parking, crosswalks, signs, and one-way streets. However, these topics are not covered in the necessary

depth for an engineer dealing directly with these topics, nor are they fully referenced to other sources.

Section 9 has a reasonable coverage of enforcement and laws and ordinances. The remaining sections deal with school children for protection, organizing a public information program, and evaluation of the ***Walk Alert*** program. The last section is a reasonable guide which lists several important sources.

Overall, this program has good coverage of public education, traffic engineering, and law enforcement. It is a very worthwhile reference to use and should be part of the resources to improve the safety of walking.

2.3.5 *Synthesis of Safety Research: Pedestrians*

Charles V. Zegeer, Federal Highway Administration, 1991

This volume synthesizes much of the research relating to pedestrian safety. It is an update of "Pedestrian Ways," Chapter 16, published in the 1982 ***Synthesis of Safety Research Related to Traffic Control and Roadway Elements.***

The synthesis covers key topics in the fields, first describing who the victims of accidents are, considering demographic factors. The temporal and spatial characteristics of accident experience are discussed. The idea of the Hazard index is elaborated on. Specific roadway elements and devices are then reviewed in turn, including pedestrian barriers, crosswalks, traffic control devices, traffic regulations, other pedestrian facilities, and auto restricted zones. Finally, consideration is given to education and enforcement.

The text provides an excellent summary of the findings from key pedestrian safety studies and would be a suitable supplementary text in training or coursework on nonmotorized transportation.

2.3.6 *Planning, Design, and Maintenance of Pedestrian Facilities*

Brian L. Bowman, John J. Fruin, and Charles V. Zegeer, Federal Highway Administration, 1989

This handbook was written to consolidate the current state of the art pertaining to pedestrian facilities. It is an adequate synthesis of current research from many of the familiar sources discussed above. This handbook is divided into eleven chapters which could form the backbone of a short course on pedestrian engineering and planning.

Chapter 2, "Pedestrian Characteristics," is drawn from the writings of Fruin and Pushkarev, and discusses the standard speed, distance, purpose, trip generation, and traffic flow ideas. Chapter 3, "Pedestrian Traffic Studies," relates how to conduct pedestrian counts, how to

determine where there are pedestrian/vehicle conflicts, and gap studies. Chapter 4, "Pedestrian Safety," discusses studies and the Model Pedestrian Safety Program. A typology of pedestrian accidents is presented comparing urban and rural areas.

Chapters 5 through 9 are traffic engineering oriented, discussing sidewalks, walkways, crosswalks, refuge islands, underpasses and overpasses, auto restricted zones, and traffic control devices. Chapter 10 is aimed at construction engineers with the topic of "Pedestrian Facilities in Work Zones," while chapter 11 discusses operations problems and maintenance.

This is a good handbook, but it is not written in the style or with the authority of a textbook. It does provide a good synthesis and should be made available to engineering students.

2.4 Specific. Residential Street Design References Available

Two recent books have been issued which deal with the design and implementation of residential streets. This topic is inherently linked with the environment of the nonmotorized traveler. The two books are:

1) ***Residential Streets,*** ASCE

2) Residential Street Design and Traffic Control, ITE

A large body of literature on livable streets has been synthesized in ***Residential Street Design and Traffic Control.*** This literature, though highly meritorious in its own right, was not formally reviewed separately.

2.4.1 *Residential Streets*

1990, American Society of Civil Engineers

The text ***Residential Streets*** was written by a task force from the American Society of Civil Engineers, the National Association of Home Builders, and the Urban Land Institute to provide general principles and design considerations regarding streets. The 100-page, large-print text is divided into five chapters: Introduction, Design Considerations, Intersections, Streets and Drainage Systems, and Pavement.

Chapter 2, "Design Consideration," is of some interest to transportation professionals concerning bicycles and pedestrians. The Guidelines are drawn from ***Recommended Guidelines for Subdivision Streets*** [ITE, 1984], and include minimizing conflict and accommodating human powered movement on residential streets. Four pages on "Pedestrian and Bicycle Access" are included in the chapter. This section states, "Careful evaluation often reveals that sidewalks on one or both sides of local residential streets (subcollectors or access streets) are unnecessary and provide insufficient benefit relative to cost." Similar arguments are made regarding roadway

width, although the minimum roadway width of 22 feet for access may still be considered excessive, particularly by those associated with the "neotraditionalist" planning movement. While sidewalks may not always be necessary, the text does not provide guidance concerning giving the pedestrian sufficient safety and protection on the roadway he is now forced onto. A short section on bicycle paths and bicycle lanes is also provided.

This book, unfortunately, does not reach its potential as a guide to good design on residential streets, particularly when compared with the superior ***Residential Street Design and Traffic Control.***

2.4.2 Residential Street Design and Traffic Control

1989, Institute of Transportation Engineers

This book is much more complete than the ASCE ***Residential Streets*** reviewed in the previous section. ***Residential Street Design and Traffic Control*** proposes techniques for slowing and diverting the flow of traffic through residential neighborhoods. In addition to describing traffic calming measures, the book includes a large bibliography of topically related publications.

After the introduction, the second chapter, "Residential Neighborhoods and Their Streets," discusses the various street network patterns that have been built historically. It elaborates on the various characteristics of these patterns, including traffic safety, and notes that application of the planning principle of hierarchy of streets, and enforcement of such hierarchy, leads to safer situations. The concept of streets for both access and movement is discussed.

The third chapter, "Planning for Traffic Control," overviews the planning and legal powers that jurisdictions have, and the desire to minimize traffic volume and speed on local residential streets. It proceeds to outline the rational planning process as applied to neighborhood traffic control, including implementation strategies.

"Design and Redesign of Neighborhood Streets," Chapter 4, depicts many different traffic control techniques, including chokers, shared surfaces, and *woonerfs*. Policies for Street Design are listed and illustrated. The context for application of each possible policy is dependent upon the historical development of the neighborhood; for instance, early 20th century grid street networks have a different set of solutions than the later curvilinear cul-de-sacs.

Chapter 5, "Tools for Neighborhood Traffic Control," discusses legal means for implementation. This is followed by an extensive listing of various traffic control devices and regulations, including means for implementation, impacts, standards, and warrants from the ***Manual on Uniform Traffic Control Devices,*** and community reaction. A discussion follows of community service impacts, including accessibility for emergency, delivery, and collection vehicles,

"Implementing Neighborhood Traffic Controls" is the last content-containing chapter in the book. This chapter acquaints the reader more fully with legal issues such as implementation authority. Conformance with standards and liability issues is also discussed. Several other topics, including public notifications, the use of temporary or permanent devices, financing, staging, evaluation, maintenance, and enforcement are also recounted.

This book, while not explicitly concerning pedestrian or bicycle design, has recommendations that inherently make residential streets more hospitable to these nonmotorized modes. Integration of modes, and their interaction, particularly concerning safety, is a topic which needs to be understood to improve the human environment on streets and roads. In any course on nonmotorized transportation, learning the implementation of good design for residential, and hopefully commercial, streets will do more to improve the environment for these modes than an explicit understanding of more technical considerations such as pedestrian flow characteristics.

3. Review of Existing Training and Professional Organizations

Existing training programs on nonmotorized transportation are so sparse as to make a chapter on them limited. The first section reviews the survey by the American Society of Civil Engineers Subcommittee on Human Powered Transportation of college and university programs, which paints a bleak picture of the potential for widespread implementation of courses on nonmotorized transportation. The second section reports the results of interviews with the chairs of several committees of the Institute of Transportation Engineers and Transportation Research Board on any training activities they may sponsor. Again little is done by the professional committees on nonmotorized transportation. The third section records the activities of the FHWA/NHTSA Pedestrian and Bicyclists Safety and Accommodations Program. The fourth evaluates the current state of transportation continuing education concerning the pedestrian and bicyclist. No current continuing education programs were identified dealing with the subject.

3.1 ASCE Subcommittee on Human Powered Transportation (HPT) Survey of University and College Offered Training

This section is drawn from a report of the ASCE Committee on Urban Transportation Facility Design and Operation, Subcommittee on Human Powered Transportation, as prepared by Mac Elliott of Phoenix, Arizona. The report is the result of a questionnaire sent to all Civil Engineering or Transportation Engineering Department Heads at 221 American colleges and universities, of which 104 responses were received.

The responses to the questionnaire were quite negative regarding the inclusion of pedestrian or bicycle material in transportation engineering coursework. Of the 104 schools that responded, only one single-unit separate course was offered in bicycle transportation and one in pedestrian transportation. Some bicycle and pedestrian material was offered as part of other courses according to 41 percent of respondents; however, only 7 percent of those are required courses. [HPTE, 1991]

Two-thirds of respondents saw no need for change in present curriculum or coverage of human powered transport. One-sixth did not respond and the other sixth did see need for change. This number is low, and reaffirms the widely held belief that by and large, engineers do not place high priority on human powered transport. There was also a low expectation for either bicycles or pedestrians to accommodate work travel. [HPTE, 1991] The land use pattern was noted to

have a great impact on the use of HPT, and thus training in HPT needs to carefully consider the land use transportation interaction.

The material that was used varied, with no dominant source. [HPTE, 1991] This provides an opportunity to design afresh a curriculum including pedestrians and bicyclists for a course (or short course) provided to transportation undergraduate and graduate students. Various organizations have training courses in transportation that go to different cities. As essentially no colleges currently offer such courses, a program specifically geared to human powered transportation taught by visiting professors with expertise may be appropriate.

The current coverage of bicycle engineering was primarily concerned with geometric design and coverage of pedestrians with safety and traffic control devices. [HPTE, 1991] Again transportation-land use interactions were not emphasized. Appendix 1 contains the full text of the report.

3.2 Activities of Transportation Professional Organizations

In addition to the ASCE Human Powered Transportation Committee discussed above, interviews were held with the chairs of several technical committees of transportation-related professional societies regarding training materials and training needs. No training materials were identified by any of the following committees, and, for the most part, training needs had not been addressed as a committee activity.

Transportation Research Board

A3B04—Committee on Pedestrians (chair: Kay Colpitts). Training activities are conducted by the Florida Department of Transportation; courses are being developed for continuing education.

A3B07—Committee on Bicycling and Bicycle Facilities (chair: Peter A. Lagerwey). No training activities were identified. Dave Daubert of the University of Minnesota is developing a Bike Transportation Module as part of a Doctoral Dissertation.

Institute of Transportation Engineers

4S-2—Pedestrian Signal Education and 4S-3—Bicycle Safety Measures (chair: Gary Euler). No training activities were reported.

5A-5—Design of Pedestrian Facilities (chair: Charles V. Zegeer). The committee's scope is to "prepare a compendium of innovative practices" which would be of interest to professionals as a training reference.

5P-3—Pedestrian Crossing Criteria (chair: Martin C. Nizlek). The committee's scope is to "investigate practices," but no training activities were reported or planned.

6A-52—Guidelines for Facilitating Pedestrian Movement within Suburban Activity Centers (chair: Kenneth S. Opiela). The committee's scope is to "compile a set of commonly used guidelines," but no training activity was foreseen.

While none of these committees are involved with training, the committee products, which are in general technical/informational reports, may be useful references for professionals who plan and design transportation facilities.

3.3 FHWA/NHTSA Bicycle and Pedestrian Safety and Accommodations Program

The proposed course will consist of several modules for a 2-day training schedule. One day will cover pedestrians, and one will cover bicycles. The purpose of the training is to inform planners, engineers, and law enforcement personnel of the various information sources available to enhance the safety of walking and bicycling and information that can lead to better accommodating both pedestrians and bicycles through design and operations. The anticipated modules are listed in table 2.

This course should lead to better understanding in meeting the real needs of pedestrians and bicyclists. Its contents are comprehensive and will build on much prior research and development over the past several years involving NCHRP project 20-19. The first phase produced NCHRP Reports 294A (Research Report) and 294B (State of the Art Report). The second phase, project 20-19(2), produced an implementation package including:

1. Several Teaching Modules (listed in Table 2),

2. Publications Focused on the Planning and Development Sector,

3. A 20-minute "Think Pedestrian" Video, and

4. Practitioner's Manual.

TABLE 2. Preliminary Course Modules in Bicycle and Pedestrian Safety Accommodations Program

- Opening
- Sustainable Transportation
- Bicycle Crash Causation
- Tort Liability and Risk Management (Planners/Engineers)
- Bicycle Rodeo/Hands-on Training (Police/Teachers)
- Bike Programs
- Principles of Design
- Bicycle Education (Police/Teachers)
- Design Policy (Planners/Engineers)
- Helmets (Police/Teachers)
- Case Studies
- Pedestrian Crash Causes
- Human Factors
- Comprehensive Planning (Planners/Engineers)
- Conspicuity (Police/Teachers)
- Handicapped
- Intersection Design (Planners/Engineers)
- Education (Police/Teachers)
- Sidewalk Design (Planners/Engineers)
- Laws and Ordinances (Police/Teachers)
- Conclusions

3.4 Survey of Continuing Education Programs

An informal survey of continuing education programs reveals much the same as the formal survey of colleges and universities performed by the ASCE Subcommittee on Human Powered Transportation. The catalogs of several major continuing education providers were also reviewed.

1) The Federal Highway Administration's National Highway Institute

2) The Traffic Institute of Northwestern University

3) The University of Maryland's Transportation Studies Center

4) The Georgia Tech Continuing Education Program

None of the above had any course which provided explicit coverage of pedestrian or bicycle issues, although as noted in the previous section, the FHWA/National Highway Institute has such a course under development at this time.

The Pedestrian Federation of America, associated with the Bicycle Federation of America, organizes an annual International Pedestrian Conference. There are workshops offered at the conference, which constitutes training. These might be a venue for continuing education of transportation professionals. Similarly, the Bicycle Federation of America also hosts conferences. Although these are advocate groups, which might be perceived as having inherent biases (particularly considering the response to the ASCE's Survey of Human Powered Transportation Education), the conferences appear to be open and objective.

4. A Course on Nonmotorized Transportation

A course on Nonmotorized Transportation could be offered as a graduate course or in a continuing education program. A large number of topics would need to be covered. An outline of course topics is presented including some recommended supplementary reference materials. Other pertinent articles and references drawn from the literature in the field would enhance the list.

I. Introduction
- A. Historical Background: People, Vehicles, and Circulation
- B. Streets for Movement and Access
- C. Functional Classification: Roads, Bikeways, Sidewalks
- D. The Street and Road Network: Scale, Spacing, Connectivity
- E. Legislation
- F. Financing
- G. Administration

REF: *Fruin,* ***Pedestrian Planning and Design***
Intermodal Surface Transportation Efficiency Act of 1991
Clean Air Act of 1990
Uniform ***Vehicle Code***

II. Land Planning to Foster NMT
- A. Density and Heterogeneity of Uses
- B. Site Design

REF: *ITE,* ***Residential Street Design and Traffic Control***

III. Nonmotorized Transportation Demand
- A. Primary Demand Estimation: Generation, Distribution, Assignment
- B. Secondary Demand (Access and Egress to Transit and Auto)
- C. Recreational Demand
- D. Demand Measurement: Counts, Density, Interaction
- E. Supply Measurement Facilities/Networks & Quality
- F. Relationship of Supply to Demand

REF: *Fruin,* ***Pedestrian Planning and Design***

IV. Operator and Operational Characteristics
- A. The Education of Pedestrians, Bicyclists, Drivers
- B. Level of Service/ Capacity
- C Relationship of Speed, Flow, and Density

REF: Fruin, Pedestrian Planning and Design

V. Design and Operation of Isolated Systems
- A. Geometric Design of Bikeways and Walkways
- B. Stairs, Escalators, Elevators, Ramps, Moving Sidewalks, etc.
- C Future Systems (People Movers, etc.)

REF: ASCE Bicycle Transportation Handbook
Fruin, Pedestrian Planning and Design

VI. Design and Operation of Integrated Systems
- A. *Woonerfs*
- B. Traffic Calming
- C. Crosswalks
- D. Bike Lanes
- E. Bike Parking/Storage
- F. Shared Roadways
- G Traffic Control Devices

REF: ITE, Residential Street Design and Traffic Control
ASCE Bicycle Transportation Handbook
Fruin, Pedestrian Planning and Design
USDOT Manual on Uniform Traffic Control Devices

VII. Mode Interactions
- A. Access to and Egress from Transit (Bus Stops, Rail Stations)
- B. Access to and Egress from Automobiles (Parking, Drop-Off)
- C. Traffic Safety Programs
- D. Other Comfort and Safety of Pedestrians and Bicyclists

REF: FHWA Synthesis of Safety Research: Pedestrians
Walk Alert: National Pedestrian Safety Program
ASCE Bicycle Transportation Handbook

VIII. Maintenance and Enforcement
- A. Maintenance Standard for Bicycle Facilities
- B. Maintenance Standards for Pedestrian Facilities
- C. Enforcement Mechanisms: Passive and Active

REF: ASCE Bicycle Transportation Handbook

5. Summary and Recommendations

This report has three major components. First, a critical review of existing reference materials was made to evaluate their coverage of pedestrian and bicycle topics. Second, existing training and professional programs were reviewed. Third, an outline for a course on nonmotorized transportation was developed and necessary reference topics were listed.

General transportation engineering and planning materials are geared primarily towards the automobile for personal transportation. These publications, including the AASHTO Green Book, ITE Handbooks, the Manual on Uniform Traffic Control Devices, and the Highway Capacity Manual are on the shelves or in the offices of most traffic engineers and transportation planners. Inclusion of pedestrian and bicycle issues is an afterthought to the general works. While some improvements can be made to the general works, it is only specific, focused texts that can comprehensively inform the transportation professional about the needs of pedestrians or bicyclists.

Unfortunately, the best specialized texts are dated. After evaluating dozens of books, and reviewing a selection of those, the most complete and unbiased bicycle text is ***Bicycle Transportation: A Civil Engineer's Notebook for Bicycle Facilities*** [ASCE 180], while the best pedestrian references is ***Pedestrians: Planning and Design*** [Fruin, 197 1]. The study of pedestrian design naturally extends itself to the so-called "Streets for People" movement. A number of excellent, though biased books cover this subject. The most objective is ***Residential Street Design and Traffic Control*** [ITE, 1989], which has the benefit of being current, as well as comprehensive. Clearly, there is room for a new and authoritative text on nonmotorized transportation planning, design, and operations.

The current state of training for transportation professionals regarding the pedestrian and bicyclist in the United States is essentially nonexistent. No complete engineering courses on nonmotorized transportation are offered. Little coverage of these topics is provided in general transportation engineering courses. As a sidelight, education in Germany is not much better. Claus Heideman reports that change in the collegiate transportation curriculum from its focus on the automobile is slow [Heideman, 1992]. If there is a desire to foster walking and bicycling for transportation as well as recreation, a change in the focus of the transportation curriculum is necessary. This change must occur in the undergraduate, graduate, and continuing education levels, particularly for Civil Engineers.

At the undergraduate level, the Civil Engineer often has only one or two transportation specific courses. Undergraduate transportation engineering courses are generally focused on

planning, geometric design of highways, and traffic operations. Other topics are noted but not studied in depth. Incorporation of pedestrian and bicycle design principles and demand estimation into the classroom and laboratory would be appropriate.

Graduate transportation education is broader, with a number of courses offered on transportation planning, traffic engineering, and other modes of transportation. A pertinent addition to the courses offered would include a course on "Planning and Design for Nonmotorized Transportation." The texts recommended earlier might form the background for such a course. Current research on nonmotorized transportation topics, particularly safety, would help to supplement the course.

A third level of transportation training is in continuing education. Programs offered by professional organizations such as the American Planning Association and the Institute of Transportation Engineers, by universities such as Northwestern's Traffic Institute and Maryland's Transportation Studies Center, as well as by the United States Department of Transportation, provide continuing education on a variety of topics. These topics do not include pedestrian or bicycle issues. With sufficient advertising and funding, a course could be test-marketed. If it proved successful, it could be offered on a regular basis. The content would be similar to a graduate level course on nonmotorized transportation.

Bibliography

In putting together a bibliography of references, one runs into the dichotomy between the studied and formal engineering and design texts, and the political and advocative policy planning texts. These serve different markets, but the professional may need to know and understand both. Advocates are focused in their desire to promote while the transportation professional has an obligation to rationally balance competing demands to provide a safe and efficient transportation system, which involves knowing and understanding what the advocate believes.

This bibliography is broken into three parts. The first is a list of publications used in preparing this report. The second lists all Federal Technology Sharing publications available. The third provides a list of currently available texts from major professional society book services.

B.1 References Used in This Report

Bicycles and Public Transportation, Replogle, Michael A., Institute for Transportation and Development Policy, Takoma Park, MD, 1983

Bicycle Transportation, Forester, John, MIT Press, Cambridge, MA, 1983

Bicycling, Transportation, and Energy: A Handbook for Planners, Gihon Jordan, published by author, Philadelphia, PA, 1984

Bicycle Transit, Balshone, Deering, and McCarl, Praeger Publishers, New York, 1975

Bicycle Transportation: A Civil Engineer's Notebook for Bicycle Facilities, American Society of Civil Engineers, New York, 1980

For Pedestrians Only: Planning, Design, and Management of Traffic Zones, Brambilla and Longo, Whitney Library of Design, New York, 1977

Guide for Development of New Bicycle Facilities, American Association of State Highway and Transportation Officials, Washington, DC, 199 1

Highway Capacity Manual, Transportation Research Board Special Report 209, Washington, DC, 1985

Highway Engineering Fourth Edition, Oglesby, Clarkson and Hicks, Gary, Wiley and Sons, New York, 1982

Highway Engineering Fifth Edition, Wright, Paul and Paquette, Radnor, Wiley and Sons, New York, 1987

Human Powered Transportation Education in U.S. Universities. Report of Results of ASCE HPT College Questionnaire, Elliott, Mac, unpublished, 199 1

Manual on Uniform Traffic Control Devices, United States Department of Transportation, Federal Highway Administration, Washington, DC, 1988

Pedestrian Planning and Design, John J. Fruin, Metropolitan Association of Urban Designers and Environmental Planners, New York, 197 1

Pedestrian Planning Design and Maintenance, Brian Bowman, John Fruin, and Charles Zegeer, FHWA, Washington, DC, 1989

A Pedestrian Planning Procedures Manual, RTKL and Associates for FHWA, Washington, DC, 1979

The Pedestrian Revolution: Streets Without Cars, Breines and Dean, Vintage Books, New York, 1974

Policy on the Geometric Design of Highways and Streets, A, American Association of State Highway and Transportation Officials, Washington, DC, 1990

"A Program of Research in Highway Capacity," Transportation Research Circular Number 37 1, Transportation Research Board, Washington, DC, 1991

Residential Street Design and Traffic Control, Institute of Traffic Engineers, Washington, DC, 1989

Residential Streets, American Society of Civil Engineers, New York, NY, 1990

Synthesis of Safety Research: Pedestrians, Charles Zegeer, FHWA, Washington, DC, 1991

Transportation and Land Development, Institute of Traffic Engineers, Washington, DC, 1988

Transportation and Traffic Engineering Handbook, Institute of Transportation Engineers, Washington, DC, 1982

Traffic Engineering Handbook, Institute of Transportation Engineers, Washington, DC, 1992

Transportation Education and Training: Meeting the Challenge (Special Report 2 10), Transportation Research Board, Washington, DC, 1984

Transportation Professionals: Future Needs and Opportunities (Special Report 207), Transportation Research Board, Washington, DC, 1985

Uniform Vehicle Code and Model Traffic Ordinance, National Committee on Uniform Traffic Laws and Ordinances, Evanston, IL, 1987

Urban Space for Pedestrians, Pushkarev and Zupan, Regional Plan Association, New York, 1975

Walk Alert: National Pedestrian Safety Program, National Safety Council, Washington, DC, 1979

B.2 Federal Highway Administration Publications

The United States Department of Transportation has published a number of documents concerning the pedestrian and bicyclist that if made widely available might assist transportation professionals in their work. The following relevant works were found in the Federal Highway Research Report Information System of the Turner-Fairbank Highway Research Center. Some may be dated, or out of print, but after review, select works could be reissued. At additional cost, some could be updated or revised. Two candidates for revision would be ***A Pedestrian Planning Procedures Manual*** and ***A Bikeway Criteria Digest.***

Bicycles

Film 098 Bikecentennial

Film 001 Bikeways Let's Get Serious

IP-8-013+ Bicycle Safe Grate Inlets Design Manual

TS-77-201 Bikeway Criteria Digest

Elderly and Handicapped Pedestrians

TS-89-42 Accessibility for Elderly and Handicapped Pedestrians

IP-87-008 Accessibility for Elderly and Handicapped Pedestrians: A Manual for Cities

IP-84-205+ Priority Accessible Network for the Elderly and Handicapped Pedestrians in Seattle (New Orleans, Baltimore)

IP-84-006 Guidelines for Making Pedestrian Crossing Structures Accessible

IP-80-008 Development of Priority Accessible Networks—Provisions for the Elderly and Handicapped Pedestrians

RD-79-146 Feasibility of Accommodating Physically Handicapped Individuals on Pedestrian Over- and Under-Crossing Structures

RD-79-001+ Provisions for Elderly and Handicapped Pedestrians (Vol. 1-3)

RD-78-142 Effective Treatments of Over- and Under-Crossings for Use by Bicyclists, Pedestrians, and the Handicapped-A Literature Review

Pedestrian Safety

Video 17 Pedestrian Safety: What You Can Do

Film 259 Special Crosswalk Illuminations for Pedestrian Safety

SA-91-034 Synthesis of Safety Research: Pedestrians

TS-89-043 FHWA Pedestrian Safety Publications (A Step in the Right Direction)

RD-89-022+ Walk Alert National Safety Program

IP-88-019 Planning, Design, and Maintenance of Pedestrian Facilities

RD-87-039+ Model Pedestrian Safety Program

IP-86-010 Methods of Increasing Pedestrian Safety at Right Turn on Red Intersections

RD-80-190 Pedestrian Safety Programs—A Review of the Literature and Operational Experience

RD-77-142+ Urban Intersection Improvements for Ped. Safety (Vol. l-5)

RD-78-169+ Pedestrian Accidents Occurring on Freeways (Vol. 1-3)

Pedestrian Planning

RD-88-036+ Measuring Pedestrian Volumes and Conflicts (Vol. 1-4)

IP-88-019 Planning, Design, and Maintenance of Pedestrian Facilities

TS-84-2 18 Proceedings, Fourth Annual Pedestrian Conference

RD-83-102 Pedestrian Signalization Alternatives

RD-79-045+ Pedestrian Planning Procedures Manual (Vol. 1-3)

IP-74-005 Manual for Planning Pedestrian Facilities (June 1974)

B.3 Publications Currently Available from Professional Societies

These are publications listed in the current catalogs of professional societies that are relevant to pedestrian and bicycle planning and design. Unlike Federal publications, there are charges for these works. Some of these have been reviewed, others are included for the informational purpose of determining what is currently available to the transportation professional.

American Society of Civil Engineers (in-catalog publications)

Bicycle/Pedestrian Planning and Design: Conference Proceedings, 708 pp, 1974, 065-4

Bicycle Transportation: A Civil Engineer's Notebook for Bicycle Facilities, 193 pp, 1980, 260-6

Planning, Design, and Implementation of Bicycle and Pedestrian Facilities, 610 pp, 1976, 170-7

Residential Streets 2nd ed., 90 pp, 1990, National Association of Home Builders

American Planning Association (in-catalog publications)

Converting Rails to Trails 3rd ed., 93 pp, 1990, Rails to Trails Conservancy

Preserving Abandoned Railroad Rights of Way for Public Use: A Legal Manual, Charles Montange, 154 pp, 1989, Rails to Trails Conservancy

Recreational Reuse of Abandoned Rights of Way, 42 pp., 1981, CPL Bibliography 66

The Pedestrian Pocket Book, Doug Kelbaugh, 68 pp, 1989, Princeton Architectural Press

The Greening of Urban Transport: Planning for Walking and Cycling in Western Cities, R.D. Tolley ed., 256 pp, 1990, Pinter Publishers

Bicycle Transportation, John Forester, 280 pp, 1983, MIT Press

Designing Effective Pedestrian Improvements in Business Districts, 60 pp, 1982, PAS 368

Livable Streets, Donald Appleyard, 336 pp, 1980, University of California Press

On Streets, Stanford Anderson ed., 424 pp, 1986, MIT Press

Transportation Research Board (in-print publications)

Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas-Research Report, 92 pp, 1987, NCHRP Report 294 A

Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas-State of the Art Report, 165 pp, 198'7, NCHRP Report 294 B

Bicycling and Bicycle Facilities Research Problem Statements, 26 pp, 1988, CIRC 337

Pedestrians and Traffic Control Measures, 76 pp, 1988, NCH SYN 139

Research Problem Statements: Pedestrians, 22 pp, 1988, CIRC 339

Pedestrian and Bicycle Planning with Safety Considerations, 45 pp, 1987, TRR 1141

Driver Performance, Pedestrian Planning, and Bicycle Facilities, 91 pp, 1988, TRR 1168

Manual ***to Determine Benefits of Separating Pedestrians and Vehicles, 56*** pp, 198 1, NCHRP Report 240

Appendix 1.

Human Powered Transportation Education in U.S. Universities. Report of Results of ASCE HPT College Questionnaire. (6/31/91)

American Society of Civil Engineers Subcommittee on Human Powered Transportation, ASCE HPT Subcom

Before the advent of the auto the bicycle functioned very well indeed, and was in the early stages of handling a major share of our transportation needs in a wide variety of weather and terrain. Providing adequate infrastructure was to be the engineer's responsibility.

Today, engineers and society are faced with the overwhelming list of problems brought in by the auto. Bicycles can address nearly every one of those problems, while offering much of the auto's flexibility and convenience. Over half our trips are 5 miles or less, ideal cycling distance. Bikes have enormous potential on the transportation scene. Yet very little of that potential is realized.

With our transportation systems designed, built, and operated by engineers, the American Society of Civil Engineers (ASCE) recently formed a Subcommittee on Human Powered Transportation (HPT Subcom) to get a handle on the problem, and to encourage engineers to become more actively involved in human powered transportation with the end. goal of realizing as much HPT potential as possible.

Formation of the Subcommittee in itself was an eye opener. Originally conceived as a small 3 or 4 person group, the immediate response generated by an appeal for members in the back pages of the ASCE Newsletter resulted in a 40-member nationwide group of civil engineers, most of them cyclists. A few specialize in pedestrian transportation. One is a lawyer. Putting all this pent-up enthusiasm and expertise to productive use has been a challenge.

As presently constructed, the HPT Subcom has a Liaison arm maintaining contact with bike and pedestrian advocacy organizations, governmental agencies, related professional organizations, and other disciplines and pertinent groups. Other Subcom groups are responsible for a) working with the technical and ASCE media, b) working with the public media, c) reviewing bike infrastructure design guidelines, d) reviewing highway capacity manuals, e) making recommendations regarding college HPT engineering education, f) reviewing HPT in other countries, g) reviewing HPT areas needing research and hopefully monitoring some of that research, h) ASCE involvement in HPT engineering seminars or conferences, i) student competitions, etc. An ambitious program for a group of volunteers.

Most practicing engineers are college graduates. The Subcom's first major project was to conduct a survey of the engineering departments of 22 1 U.S. colleges and universities to determine the current status of bicycle and pedestrian transportation engineering education. One hundred four responses were received. As had been expected, results indicated the present amount of HPT education was minimal or nonexistent. The educators, however, had a number of clearly expressed concerns, particularly regarding bicycling, that they felt needed to be addressed. Their Number 1 concern by far was their perception of safety. Weather, terrain, inadequate

infrastructure, speed (time of travel), parking, after-dark safety (muggings) were also major bike concerns. Limited carrying capacity of bikes, comfort and convenience of cars, need to change clothes at work, and cultural attitudes towards cyclists were all seen to limit bike potential.

It is obvious that the foregoing concerns need to be addressed, by research or otherwise, if we are to convince educators (and ultimately their engineer graduates) that bikes ARE practical, SHOULD be taught, and SHOULD be included in our transportation system. Seeing that these concerns ARE addressed is now the Subcom's first priority. This Subcom is optimistic.

Traffic and highway engineers have been recently held in something less than high regard by cycling and pedestrian advocates. Viewed by some as unresponsive to public wishes, engineers were bypassed, excluded from the HPT loop where possible. On the other hand, engineers felt their concerns were downplayed or ignored by advocates. Results were predictable: a system in which cycling and walking were either shut out or greatly limited in practicality.

Such an adversarial role between engineers and cycling and walking advocates was obviously no-win, and obviously not intentional. Neither side seemed particularly aware that it existed. The HPT Subcom is working to improve communications, and attempting to have the concerns of ALL parties recognized and properly addressed. We need each other. We all have a common interest in affordable, efficient, effective, sustainable, and environmentally sound mobility. That's another definition for Human Powered Transportation.

Anyone wishing further info on activities of this ASCE HPT Subcom may contact Mac Elliott, Chair, at 6616 North 14th Street, Phoenix, AZ 850 14, (602) 265-67 12.

August 1991

Appendix 1 A-'The Questionnaire

ASCE Questionnaire - 2/26/9 1 Sheet 1 of 4

Bicycle and Pedestrian Education in College Transportation Engineering Courses

Name of Institution_____ Date_____

Name, Title, & Department of Person Answering Questionnaire
(or Contact Person)_____

1. Does any department teach courses devoted specifically to BICYCLE facility planning and/or design? Yes____No____
   Which department(s)?_____Contact(s)_____
   How many credit hours? Undergraduate____ Graduate____

   la. Ditto for specific PEDESTRIAN courses.

2. Are BIKE facility planning and/or design incorporated into other courses?
   Yes____ No____ Which department(s)?_____

   Contact person(s)_____
   Title of course & number of credit hours_____

   What percent of course time is devoted to bikes?_____

   2a. Ditto for PEDESTRIAN material in other courses.

3. Is education in BIKE facility planning and/or design required for an undergraduate degree in transportation engineering? Yes____ No____
   A graduate degree? Yes____ No____
   How many credit hours?____ Comments:

   3a. Ditto for PEDESTRIAN facilities.

ASCE Questionnaire Sheet 2 of 4

4. BICYCLING Texts and Teaching Materials Used. Please list.

4a. PEDESTRIAN Texts and Teaching Materials Used. Please list.

5. Source of BICYCLING Transportation Instructors_____

5a. Source of PEDESTRIAN Transportation Instructors.

6. Any special training or expertise required of BICYCLING transportation instructors? Yes____ No ____. If Yes, please list. Add any comments. See also Item No 6b.

6a. Ditto for PEDESTRIAN transportation instructors.

6b. Instructors in traffic engineering and highway design draw on their backgrounds as experienced MOTORISTS to help develop judgment regarding correctness of course materials. Is it important that CYCLING transportation instructors be experienced CYCLISTS? Yes__ No___. Comments:

ASCE Questionnaire Sheet 3 of 4

7. BICYCLE Course Content: Please list specific items covered.

7a. PEDESTRIAN Course Content: Please list specific items covered here or under Item No. 13.

8. Does your institution see need for changes in college BICYCLE or PEDESTRIAN transportation engineering education? Yes____ No____. If Yes, please list.

9. What transportation mode is used to and from campus by your:

	% Auto	% Trans	% Bike	% Walk
Students				
Faculty				
Staff				

(Skip this question if info is not readily available.)

10. Does your campus have a BICYCLE Coordinator on staff? Yes____ No____
Are bikes registered? Yes____ No.____ How many? ____

10a. Does your campus have a PEDESTRIAN coordinator on staff? Yes___ No___

11. What percent of U.S. work trips can realistically be BICYCLE trips?
Percent?___.___ Comments:

11a. What percent of U.S. work trips can realistically be WALKING trips?
Percent?___.___ Comments:

ASCE Questionnaire Sheet 4 of 4

12. What BICYCLING or PEDESTRIAN transportation research is needed? Please list.

13. Other Comments. Use additional sheets if necessary.

Appendix 1 B-Tabulation of Answers

List of Symbols Used in Tabulation of Answers to ASCE College Questionnaire on Human Powered Transportation

A	-	AASHTO GUIDE (or Architectural Dept in Questions 2 & 2a only).
C	-	ASCE Bicycle Transportation 1980 (A Civil Engineer's Notebook for Bicycle Facilities).
CE	-	Civil Engineering Dept. (or Transportation Engineering Dept. where applicable). Questions 2, 2a, 5, & 5a.
Con	-	Consultants (used as instructors).
D	-	Differs, or Depends (on location, weather. terrain, etc).
F	-	FHWA.
H	-	Highway Capacity Manual.
L	-	Local or State Bicycle Facility Manuals or Guidelines.
LA	-	Landscape Architecture Dept. Questions 2 or 2a.
M	-	Miscellaneous texts, reference materials, class notes, etc.
N	-	No, or None, as applicable.
NN	-	No to 1st part, No to 2nd part. (Typical of N & Y, e.g., NY means No to 1st part, Yes to 2nd part, etc.).
O	-	Omitted or Overlooked the answer.
P	-	Personal Experience, used as source of instructional material.
S	-	See the individual college's response for additional information.
T	-	Transp Engr'g education is req'd for instructor. Note: Most 'N' answers in Questions Nos. 6, 6a & 6b probably mean the same as 'T' answers in those same questions.
U	-	Answer is Unknown.
UP	-	Urban Planning Dept. Questions 2 or 2a.
V	-	Varies, (course content), according to instructor.
Y	-	Yes
YY	-	Yes to 1st part, Yes to 2nd part. (See NN above for notes.)

Numbers: Percent of a 3- or 4-unit course devoted to bike or pedestrian subjects, at Questions Nos. 2 & 2a.
Number of credit hours required, at Questions No. 3 & 3a.
Hundreds of bikes registered, at Question No. 10, e.g, '5' = 500 bikes registered.
Percent of U.S. work trips, at Questions Nos. 11 & 11 a.
Percent of trips to & from campus made by a mode.
Question 9 separate breakdown sheet.

/ - A slash (/) is used between 2 letters only for clarity. Not used when space is insufficient. e.g.:

Y/CE<5/S means: 'Yes,' 'CE Dept,' 'Less than 5% of a 3 or 4 unit course,' 'See response for add'l info.'
NY50 means: 'NO,' 'Yes,' '5000 bikes registered,' (at Question #10).
AMS means: 'AASHTO Guide.' 'Misc text materials,' 'See college response for additional info.'
CES means: 'CE Dept,' 'See college response for add'l info.'

Answers to 2/26/91 ASCE College Questionnaire on Human Powered Transportation
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State & Inst.	1	1a	2	2a	3	3a	4	4a	5	5a	6	6a	6b	7	7a	8	9	10	10a	11	11a	12	13
AL-Auburn Univ.	N	N	Y/CE	Y/CE	NN	O	O	O	O	0	0	0	Y	S	S	YS	O	NS	N	50/S	0	s	s
AL-U of Al, Birmhm	N	N	N	N	N	N	N	N	N	N	0	0	0	N	N	N	0	0	0	0	0	0	0
AL-U of Al, Tsclsa	N	N	Y/CE/5	Y/CE/2	NN	NN	N	N	N	N	T/S	T/S	N	N	N	N	S	NN	N	0	0	0	0
AR-U of Arkansas	N	N	N	N	N	N	N	O	O	O	0	0	0	0	0	0	0	NN	N	0	0	0	0
AZ-No Az Univ.	N	N	N	N	N	O	0	0	0	0	0	0	N	0	0	0	0	OY12	0	D	D/S	S	S
AZ-U of Arizona	N	N	Y/CE/3	Y/CE/3	s	S	P/M	H/M	CE	CE	T	T	N/S	N	N	U	0	YYS	N	D	D		SS
CA-Cal Poly St U SB	N	N	Y/CE<5<S	Y/CE<5/S	NNS	0	AMS	AMS	CE	CE	T	N	NS	0	0	N	0	NSN	N	10/S	I-2	N/s	
CA-Cal St Poly Pna	N	N	Y/CE/3/S	Y/CE/2/S	NN	NN	0	0	0	0	N	N	0	S	S	N	S	N	N	D	D	0	0
CA-Cal St U. Chico	Y/C	N	Y/CE<5	N	NN	NN	ALC	N	U	0	0	0	U/S	Y/S	N	0	0	NYU	N	5-95	2-10	0	s
CA-Cal St U. Fresno	N	N	N	N	NN	NN	N	N	N	N	0	0	N	O	O	N	0	NY	N	0	0	0	0
CA-Cal St U. Sacto	N	0	Y/CE/3	Y/CE/1	NNS	N	S	S	CE	CE	N	N	N	0	0	N/S	S	NN	N	5/S	4/S	u	s
CA-San Fran St U.	N	N	N	N	NN	NN	N	N	N	N	0	0	N	N	N	Y/S	s	NN	N	U	U	S	O
CA-U of Pacific	N	N	N	N	N	N	O	O	O	0	0	0	0	0	0	0	0	0	0	0	0		00
CO-U of Col Boulder	N	N	N	N	N	N	N	N	N	N	0	0	0	N	N	N	S	NYU	N	40	20	N/S	N
CO-USAF Academy	N	N	N	N	NN	NN	N	N	N	N	0	0	N/S	N	N	Y/S	0	NN	N	30	1	0	0
CT-U of Conn.	N	N	N	N	N	N	N	N	CE	CE	N	N	N	N	N	N	S	NN	N	3	3	s	o
CT-U of Hartford	N	N	N	N	N/S	N	N	N	N	N	0	0	0	N	N	N	S	NN	N	u	u	0	0
CT-US Coast Gd Acd	N	N	N	N	N	N	O	O	O	O	0	0	0	Y	O	O	N	S	NN	N	0	0		00
DC-Howard Univ.	N	N	N	0	N	N	O	N	N	N	0	Y	0	N/S	N	N	N	S	NN	Y	2/S	1	s	s
DC-U of Dst of Col	N	N	Y/CE/1	Y/CE/2	N	N	US	S	CE	CE	0	0	Y/S	0	0	N	S	NNS	N	15/D	I/D	S	S
DE-U of Delaware	N	Y	N	0	N	O	0	0	0	0	0	0	0	O	O	Y	s	NN	N	0.5	0.5	S	O
FL-Fl A&M/Fl St U	N	N	N	N	Y/3	Y/3	N	N	N	N	0	0	0	0	0	0	s	N	N	*u*	*0*	*O*	*O*
FL-Fl St Inst Tech	N	N	N	N	NNNNNN			N		N		N		0	0	Y/S	s	NN	N	10/D	5/D	S	0
FL-U of Cent Fl Orl	N	N	Y/CE/1	N	N	N	N	N	O	0	N	0	N	O	O	N	0	NY2	N	N	D		SO
FL-U of Fl Gainsvle	N	N	Y/CE/5	Y/CE/5	NN	NN	N	N	N	N	N	N	N	N	N	N	U	NN	N	I/D	I/D	S	N
FL-U of So Florida	N	N	Y/CE/5	Y/CE/5	NN	N/S	N	N	CE	CE	N	N	S	N/S	N/S	N/S	S	NY	N	25/S	5/S	0	0
ID-U of Idaho	N	N	N	N	N	N	O	O	O	0	N	N	0	0	0	0	0	N	N	0	0	0	0
IL-Ill Inst of Tech	N	N	Y/CE/A/15	Y/CE/A/15	YYS		YYS		S	S	0	S	T	T	S	S	S	0	0	0	0	0	0
IL-U of Ill. Urbana	N	N	N	Y/S	O	O	O	H	O	H	N	0	N	0	H	Y/S	0	0	0	0	0	0	0
IN-Ind Inst of Tech	N	N	N	N	N	N	O	O	U	0	0	0	0	O	O	N	S	NN	N	0	0	0	0
IN-Purdue Univ.	N	N	Y/CE/10	Y/CE/10	NN	NN	M	M	0	CE	N/S	N/S	Y/S	V	V	N	0	YN	Y	u	u		so
IN-Tri St U. Angola	N/S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	s	N	N	10/D	10/D	0	0
IN-U of Notre Dame	N	N	N	N	NNNNN			N		N		N		N	N	N	0	N	N	0-5s	0-5s	0	0

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State & Inst.	1	1a	2	2a	3	3a	4	4a	5	5a	6	6a	6b	7	7a	8	9	10	10a	11	11a	12	13
IN-Valparaiso U.	N	N	N	N	N	N	O	O	O	0	0	0	0	0	0	Y/S	S	N	N	0	0		00
KS-K State U.	N	N	N	N	N	N	O	O	O	0	0	0	0	0	0	N	S	NY	N	0	0	O	S
KS-U of Kansas	N	N	Y/CE/5	Y/CE/5	NN	N	N	N	N	N	N	N	N	N	N	N	S	NN	N	D	D		SS
KY-U of Kentucky	N	N	N	U/S	NNNOON			N		0		0	N/S	N	N	U/S	0	NN	N	0-3s	0-3s	0	0
LA-U of New Orlns	N	N	N	N	N	N	O	O	O	0	0	0	0	0	0	Y/S	S	NN	N	80/S	10/S	S	S
IA-U of SW Louisna	N	N	N	N	N	N	N	N	N	N	0	0	N	N	N	N	0	NN	N	0	0	0	0
MA-Northeastern U.	N	N		Y/CE/1	N	N	N	N	N	N	0	0	N/S	0	Y/S	N	0	NN	N	10/S	10/S	0	s
MA-Tufts Univ.	N	N	Y	N	NN	NN	N	N	N	N	N	N	YNS	N	N	N	0	NN	N	u	u		u	s
MA-U of M Amherst	N	N	Y/CE/U	0	NN	NN	0	0	0	0	N	N	Y/S	0	0	N	0	N	N	1-10	I-10	u	0
MD-U of Maryland	N	N	N	0	N	O	0	0	0	0	Y	0	N	0	0	Y/S	0	N	U	0	0	0	0
MI-Lawrence Tech U.	N	0	N	Y	N	O	0	0	0	0	0	0	Y	O	O	N	S	NN	N	0	0	s	0
MI-Michigan St U.	N	N	Y/CE/5	Y/CE/5	NN	N	0	0	CE	CE	N	N	N	S	S	N	S	NY50	N	5/D	5/D	S	0
MI-U Detroit Mercy	N	0	N	0	N	O	0	0	0	0	0	0	0	0	0	N	S	NN	N	1	1	0	0
MI-U of Michigan	N	0	N	0	N	O	0	0	0	0	0	0	0	0	0	N	S	NN	N	3/D	5	0	0
MO-U of Mo Columbia	N	N	N	N	NN	NN	N	N	N	N	N	N	N	N	N	N	S	NN	N	5	5	0	0
MO-U of Mo K.C.	N	N	N	N	NN	NN	N	N	N	N	0	0	Y	N	N	Y/S	s	NN	N	U	U	S	0
MS-U of Miss.	N	0	N	0	N	N	O	O	O	O	0	0	0	N	O	O	N	S	N	N	10	10	u	0
NC-Duke Univ.	N	N	N	N	NNNNNO			N		N		N		Y		NNS	0	NY	N	0-5s	o-5	0	s
NC-NC A&T St Univ.	N	N	N	N	N	N	O	O	O	0	0	0	0	0	0	N	0	NN	U	u	u		00
NC-NC State U.	N	N	Y/CE<10	Y/CE<10	NN	N	H	H	N	N	N/S	N/S	S	S	S	N	U	NY	N	U	U	U	S
ND-N Dakota St U.	N	N	Y/CE<5	Y/CE<5	Y/S	0	N	N	CE	CE	Y	N	N	0	0	N	S	NY	N	5	5	0	0
ND-U of N Dakota	N	N	Y/CE/2	Y/CE/2	N	N	S	S	CE	CE	N	N	N	S	S	N	S	NN	N	10	10	0	s
NE-U of Neb. Lncln	N	N	Y/CE/5	Y/CE/5	NN	NN	AHM		AHM	0	0	N	N	N	G/S	S	N	0	NN	N	u	u		so
NM-New Mexico St U.	N	0	Y/CE<10	0	N	N	O	N	N	N	N	0	N	0	0	Y/S	s	Y/S	Y/S	u	u	0	0
NM-U of New Mexico	N	0	Y/CE/3	Y/CE/3	NN	NN	A		FM	CE	CE	N	N	N/S	0	0	N	S	NY	N	10/D	<5	S	0
NV-U of Nev Las Veg	N	0	Y/CE/5	Y/CE/5	NN	NN	S	S	CE	CE	N	N	Y/S	0	0	N	S	U	U	10/D	S	0	0
NY-City Coll of NY	N	N	N	Y/CE/6-15	N	N	N		MIS	N		CE	N	N	0	0	S	N	0	NN	N	1/S	5/S	s	0
NY-Clarkson U.	N	N	N	Y	N	N	N		H	N		CE	N	N	Y	N	S	N	0	N	N	N		SO
NY-Cornell U.	N	N	N	N	NN	NN	0	0	0	0	0	0	0	0	0	O/S	S	NY	N	D	D		SO
NY-Manhattan Coll.	N	N	N	N	NN	NN	N	N	0	0	0	0	0	O	O	N	S	N	N	u	u		00
NY-Rensselaer Poly	N	N/S	N	N	NN	NN	N	N	0	0	0	0	0	0	0	N	S	NN	N	70/S	80/S	S	0
OH-Ohio Northern U.	N	N	Y/UP<10	Y/UP<10	NN	NN	0	0	0	0	N	0	N	0	0	N	S	NN	N	<5	<50	O	0
OH-Ohio State U.	N	N	N	N	NN	NN	N	N	N	N	N	N	Y	N	N	N	0	NN	N	U	U	0	S

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State & Inst.	1	1a	2	2a	3	3a	4	4a	5	5a	6	6a	6b	7	7a	8	9	10	10a	11	11a	12	13
OH-U of Dayton	N	N	Y/CE<5	Y/CE<5	YNS	YNS	AMS	AMS	U	U	N	N	NTS	O	O	Y/S	S	NN	N	51s	2	s	s
OH-U of Toledo	N	N	Y/O	N	NN	N	HS	N	CE	CE	N	N	N	S	S	N	S	NN	N	3-5D	2-3D	S	N
OH-Youngstown St U	N	N	N	N	NN	NN	N	N	N	N	N	N	N	N	N	N	S	NU	N	U	U	N	D/S
OK-U of Oklahoma	N	N	Y/CE/3/S	Y/CE/3/S	NN	NN	N/S	N/S	T	T	T	T	U	0	0	N	0	NY	N	D	D	S	0
OR-Oregon St U.	N	N	Y/CE	Y/CE	NN	NN	A	HS	Con	0	N/S	0	Y/S	0	0	N	0	YY	N	13/S	5-10	s	0
PA-Bucknell U.	N	N	U/CE<5	U/CE<5	N	N	NNO			0	0	0	0	0	0	N	S	NY	N	0	0	0	0
PA-Carnegie Mellon	N	0	N	0	N	N	O	O	O	0	0	0	0	O	O	N	ON		N	3	3	0	0
PA-Drexel Univ.	N	0	Y/CE/5/S	0	NN	0	N	N	CE	N	0	0	Y	N	N	Y	s	YYU	Y	u	u	s	0
PA-Lehigh Univ.	N	N	0	0	N	N	O	O	O	0	O	0	O	O	O	N	S	NN	N	1-2S	2-5	S	0
PA-Penn State	N	N	Y/CE/1	Y/CE/1	NN	0	F	F	CE	0	N	N	N	S	S	N	ON		N	0	0	S	O
PA-Villanova U.	N	N	N	N	N	N	N	N	N	N	N	N	0	0	0	0	S	NN	N	0	0	0	S
PA-Widener Univ.	N	N	Y/CE/3	Y/CE/3	NN	N	N	N	CE	CE	N	N	Y	N	N	Y/S	S	NN	N	U	U	0	0
PR-U of Puerto Rico	N	0	N	0	N	O	N	N	N	N	0	0	N	N	N	N	S	NN	N	5	5	S	0
RI-U of Rhode Is.	N	N	Y/CE/2	Y/CE/2	Y/S	Y/S	s	S	CES	CES	N	N	0	S	S	YN	S	NN	N	5	10	S	0
SC-Clemson Univ.	N	N	N	N	N	N	O	O	O	O	O	O	O	0	0	N	S	NN	N	U	U	0	0
SC-The Ciidel	N	N	Y/CE/1	Y/CE/1	Y	N	S	N	M	M	N	N	N	N	U	N	N	U	S	NN	N	0	0	0	0
SC-U of So Carolina	N	N	N	N	NN	NN	N	N	N	N	N	N	N	N	N	U	S	NYU	N	5	2	N	0
SD-So Dak St Univ.	N	N	Y/LA/10	Y/LA/10	NNOSSN			N		N		N	Y			NNS	S	NY	Y	D/S	10	0	S
TN-Christian Bro U.	N	N	N	N	N	N	N	N	N	N	N	0	0	N	N	N	S	NN	N	U	U	0	0
TN-Tenn Tech U.	N	N	Y/CE/1	Y/CE/2	NN	N	A/M	AIM	CE	CE	N	0	Y	0	0	N/S	S	NN	N	0-3s	0-5s	s	s
TN-U of Tenn.	N	N	N	N	N	N	N	N	O	0	N	N	N	0	0	N	S	NN	N	D/S	D/S	0	S
TX-Prairie View A&M	N	N	N	N	N	N	O	O	O	0	0	0	0	0	0	0	00		0	0	0	0	0
TX-Texas A&M Univ.	N	N	N	N	N	N	N	O	O	O	0	0	0	N	0	0	N	O	YY	Y	0	0	0	0
TX-Texas Tech U.	N	N	N	N	N	N	N	N	N	N	N	N	N	YIS	N	N	N	0	OY	0	2	1	N	0
TX-U of Tx. Austin	N	N	Y/CE/5	Y/CE/5	NN	N	S	S	CE	CE	N	0	N	YIS	N	Y/S	0	N	N	5	5	0	0
UT-Utah State U.	N	0	N	0	N	O	N	N	O	0	0	0	Y	N	N	Y	OU		U	S	0	O	S
VA-Virg Mil Inst.	N	0	Y/CE/2	Y/CE/2	N	0	S	S	N	N	N	0	N	S	S	N	0	N	N	<1	S	0	0
VA-Virginia Tech	N	N	Y/CE/5	Y/CE/5	NNNNNU			U		N		N	N	N	N	N	S	NN	N	<1	<1	N	0
VT-Norwich U.	N	N	Y/CE/2	Y/CE/2	N	N	S	S	N	N	N	N	Y	0	0	N	S	NN	N	N/D	0	0	0
VT-U of Vermont	N	N	N	Y/CE/5	N	N	0	H	0	CE	N	N	U	0	Y/S	N	0	NN	N	D	D	0	0
WA-St Martin's Ccl	N	N	N	N/S	N	N	N	N	N	N	0	0	O	0	0	N/S	S	NN	N	10	5	S	S
WA-U of Washington	N	O	N	0	N	N	O	O	O	O	0	N	0	N	0	0	N	S	NN	N	2	2	S	0
WA-Washington St U.	N	N	N	N	YN3	YN3	0	0	0	0	N	N	Y	O	O	N	00		0	0	0	S	S

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WI-Marquette U.	N	0	N	YiCEi5	NN	N	N	H/S	O	0	0	T	0	0	S	N	0	NN	N	15/D	2-3D	S	0
WI-Milwke Sch of Eng	N	N	N	0	N	O	0	0	0	0	0	0	0	O	O	N	S	N	N	0	0	0	0
WI-U of Wisc Mlwke	N	0	YiCEi5	Y/CE/5	NN	0	A	S	CE	CE	N	0	N	O	O	N	S	N	N/S	40/D	25	S	0
WV-W Virginia U.	N	N	Y/CE/9	Y/CE/9	NN	NN	AMS	FMS	CE	CE	N	N	N/S	S	s	Y/S	s	NN	N	<5	<5	S	S
WY-U of Wyoming	N	N	Y/CE<5	Y/CE<5	NN	NN	M	M	0	0	0	0	0	O	O	N	O	N	N	2-4	2-4	s	0

Transp Modes Used To & From Campus by Students, Faculty, & Staff (Percents)
File: ASCE Campus Per
Report: Question 9 Answers

St & Inst	Aut Stu	Aut Fac	Sautt f	Tst Stu	Tst Fac	Sstt f	Bik Stu	Bik Fac	Bik Stf	Wlk Stu	Wlk Fac	Wlk Stf
AL-Auburn												
AL-UoA Bm												
AL-UoA Tsa	85	99	99	0	0	0	5	0	0	10	1	
AR-UoArk												
AZ-NAU												
AZ-UoAz												
CA-CPSU SB												
CA-CSP Porn	80											
CA-CSU Chi												
CA-CSU Frsn												
CA-CSU Sac	91	99	97	4.0	0.5	2.0	1.0	0.25	0.5	4.0	0.25	0.5
CA-SFSU	40	70	60	50	20	30	5	0	0	10	10	10
CA-UoPac												
CO-UoC Bldr	20	60	50	10	10	10	50	20	30	20	10	10
CO-USAF												
CT-UoCon	90	98	98	10	2	2	0	0	0	0	0	0
CT-UoHartf	>90	>90	>90									
CT-USCG	0	99	97	0	0	2	0	1	1	0	0	0
DC-Howrd U	30	97	37	30	1	60	1	1	1	30	1	2
DC-UoDC	70	90	80	28	8	8	<1	<1	<1	<1	<1	<1
DE-UoDel	25	95	95	10	0	0	5	0	0	60	5	5
FL-A&M	0	90	0	0	9	0	0	1	0	0	0	0
FL-FSIT Tech	20	90	90	0	0	0	10	5	5	70	5	5
FL-UoCF Or												
FL-Uof Gn												
FL-UoSF	80	97	95	2	1	2	1	1	1	17	1	2
ID-Uoid												
IL-IloTech												
IL-Uol Urb												
IN-IloTech	90	95	95	4	5	5	1	0	0	5	0	0
IN-Purdue												
IN-TSU Ang	60	>95	>95	0	0	0	0	0	0	40	<5	<5
IN-UoNotrD												

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St & Inst	Sutt u	Aut Fac	Aut Stf	Tst Stu	Tst Fac	Sstt f	Sikt u	Bik Fac	Bik Stf	Wlk Stu	Wlk Fac	Swlkt f
IN-Valp U												
KS-KSU	30	95	95	0	0	0	15	3	2	55	2	3
KS-UoKan	33	85	95	20	1	0	13	6		33	8	4
KY-UoKen												
LA-UoNO	91	94	94	4	1	2	4	2	2		3	2
LA-UoSWL												
MA-NEU												
MA-Tufts												
MA-UoM Am												
MD-UoMd												
MI-Lawr T	100+/-	100+/-	100+/-	0	0	0	0	0	0	0	0	0
MI-MSU	20	95	80	0	0	10	10	5	5	70	0	5
MI-UDMerc	90	100	95	10	0	5	0	0	0	0	0	0
MI-UoM	10	70	80	30	5	10	20	10	0	40	15	10
MO-UoM Col	50	95	95	20	0	0	10	0	0	20	5	5
MO-UoM KC	90	95	95	10	0	0	0	0	0	0	0	0
MS-UoMiss	90	95	95	0	0	0	5	3	3	5	2	2
NC-Duke												
NC-NC A&T												
NGNCSU												
ND-NDakSU	50	80	80	10	5	5	20	5	5	20	10	10
ND-UoNDak	50	80	0	5	0	0	0	0	0	45	20	100
NE-UoNeb L												
NM-NMexSU	80	90	90	0	0	0	15	5	5	5	5	5
NM-UoNMex	35	90	U	5-10	<5	0	2-3	2-3	0	2-3	2-3	0
NV-UoNLV	70	100	100	0	0	0	5	0	0	25	0	0
NY-CCNY												
NY-Clksn U												
NY-Cornell		90	90	1	1	10	3	4	0	95	5	0
NY-Man Col	90	90	75	10	0	0	0	0	0	0	10	25
NY-Rens P	10	90	90	5	0	0	5	0	0	80	10	10
OH-ONorU	50	50	60				2	5	0	48	45	40
OH-OSU												

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St & Inst	Aut Stu	Aut Fac	Aut Stf	Tst Stu	Tst Fac	Tstf	Bik Stu	Bik Fac	Bik Stf	Wlk Stu	Wlk Fac	Wlk Stf
OH-UoDayton	20	>90	>90	10	9-10	9-10	10	1	1	60	0	0
OH-UoToledo	25	95	90	30	0	5	0-1	0	0-1	45	5	5
OH-Yngstn SU	90	100	100	10	0	0	0	0	0	10	0	0
OK-UoOkl												
OR-OrSU												
PA-Bcknl U	5	95	98	0	0	0	1	1	0	94	4	2
PA-CarnMell												
PA-Drxl U	15	60	50	20	30	40	5	3	4	60	7	6
PA-Lehigh U	5	95	95	15	2	2	<1	<1	1	80	3	3
PA-Penn St												
PA-Vill U	75	85	60	10	10	40	5	1-2	0-1	10	1-2	0-1
PA-Widr U.	35	90	90	5	5	5	10	0	0	50	5	5
PR-UoPrto R	75	97	90	0	0	0	7	3	3	18	0	7
RI-UoRI	20	90	90	2	2	3	2	2	1	76	6	6
SC-Clmsn U	88	92	96	0	0	0	2	0	0	10	8	4
SC-The Cit										100	50	90
SC-uosc		95	95		0	0		0	0		5	5
SD-SDakSt U	20	90	90	0	0	0	10	5	5	70	5	5
TN-ChstnBro	95	98	90	0	0	5	0	0	0	5	2	5
TN-TnTech	x	x	x	0	0	0	x	x	x	x	x	x
TN-UoTn	92	98	98	3	1	1	0	0	0	5	1	1
TX-PrVw A&M												
TX-Tex A&M												
TX-Tex Tech												
TX-UoTx Aus												
UT-Ut St U												
VA-VMI												
VA-Virg T	5	95	95	80	1	1	5	0	0	10	4	4
VT-Norwch U	5	50	60	5	10	10	0	0	0	90	40	30
VT-UoVtp												
WA-StMarCol	85	85	90	5	0	5	0	5	0	10	10	5
WA-UoW	40	60	60	40	20	20	10	10	10	10	10	10
WA-WSU												

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St & Inst	Aut Stu	Aut Fac	Aut Stf	Tst Stu	Tst Fac	Tst Stf	Bik Stu	Bik Fac	Bik Stf	Wlk Stu	Wlk Fac	Wlkt f
WI-Marqte U												
WI-MilScEng	2 0			10			1			69		
WI-UoWi Mil	30	70	70	50	15	15	10	5	5	10	10	10
WV-WVU	79	99	96	0	0	0	1	<1	1	20	1	3
WY-uowy												

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St & Inst	Aut Stu	Aut Fac	Aut Stf	Tst Stu	Tst Fac	Tst Stf	Bik Stu	Bik Fac	Bik Stf	Wlk Stu	Wlk Fac	Wlkt f
WI-Marqte U												
WI-MilScEng	2 0			10			1			69		
WI-UoWi Mil	30	70	70	50	15	15	10	5	5	10	10	10
WV-WVU	79	99	96	0	0	0	1	<1	1	20	1	3
WY-uowy												

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